INTERNATIONAL JOURNAL OF SCIENCE AND NATURE

www.scienceandnature.org

A COMPARATIVE EVAULATION OF PHYSIOTHERAPY MODALITIES IN IMPROVING HAND FUNCTION AMONG STROKE SURVIVORS

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ABSTRACT
The purpose of the study was to evaluate and compare the effectiveness of neuromuscular electrical stimulation and Cryotherapy in the management of spasticity in elbow flexors among stroke survivors thereby improving hand function. An experimental design was used in this study ,which consists of (n=30) subjects, these all subjects were 3 weeks post-stroke after through assessment and qualifying the inclusion criteria were included. Parameters used for the study are modified as worth scale for spasticity and Fugl-Meyer post stroke assessment of physical performance for functional ability of the wrist and hand component. These subjects were assigned in to two groups by a purposive random sampling method and treated by physiotherapy modalities (one group with neuromuscular electrical stimulation and re-education exercises and another group were treated with cryotherapy and re-education exercises) for a duration of 3 months alternate days treatment. Data were collected and cleaned and paired and unpaired't' test were performed in order to examine the significant level of the interventions. In conclusion reduction of spasticity and improvement of voluntary hand and wrist control in post stroke survivors with help of neuromuscular electrical stimulation (NMES) and cryotherapy was achieved after 3 months of treatment sessions in both the groups. But comparatively there is no significant difference between the interventions.

KEY WORDS: Neuromuscular electrical stimulation, Cryotherapy, Stroke rehabilitation, Physiotherapy, spasticity.

INTRODUCTION

Stroke is defined as a clinical syndrome characterized by rapidly developing clinical signs of focal or global disturbance of cerebral function with symptoms lasting 24 hours or longer or leading to death with no apparent cause other than of vascular origin[1]. Stroke was the second most frequent cause of death worldwide in 2008, accounting for 6.2 million deaths (approx 11% of the total) [2]. Approximately 17 million people had a stroke in 2010 and 33 million people have previously had a stroke and were still alive. Between 1990 and 2010 the number of strokes decrease by approximately 10% in the developed world and increased by 10% in the developing world. Overall two thirds of strokes occurred in those over 65 year's old[3]. The incidence of stroke increases exponentially from 30 years of age, and etiology varies by age[4]. Advanced age is one of the most significant stroke risk factors. 95% of strokes occur in people age 45 and older, and two-thirds of strokes occur in those over the age of 65[5,6]. Stroke is also a predisposing factor for epilepsy, falls and depression in developed countries[7], and is a leading cause of functional impairments, with 20% of survivors requiring institutional care after 3 months and 15% - 30% being permanently disabled[8]. Stroke is no longer a disease of the developed world: Low and middle-income countries account for 85.5% of total stroke deaths worldwide and the number of disability-adjusted life years in these countries was approximately seven times that in high-income countries[9]. In India, the ICMR estimates in 2004 indicated that stroke contributed 41% of deaths and 72% of disability adjusted life years amongst the non-communicable diseases[10]. The Indian National Commission on Macro-economic and Health estimated that the number of strokes will increase from 1,081,480 in 2000 to 1,667,372 in 2015[11].

A stroke, sometimes referred to as a cerebrovascular accident (CVA), is the rapid loss of brain function due to disturbance in the blood supply to the brain. This can be due to ischemia (lack of blood flow) caused by blockage (thrombosis, arterial embolism), or a hemorrhage[12]. As a result, the affected area of the brain cannot function, which might result in an inability to move one or more limbs on one side of the body, inability to understand or formulate speech, or an inability to see one side of the visual field[13]. Motor impairment after stroke is a major cause of permanent disability. Recovery of the hand is crucial in order to perform activities of daily living but is often variable and incomplete. The legs also frequently recover to greater extent and the voluntarily control of the arm movement is likely to return, and it is better for the proximal than for distal segments[14]. The different types of interventions that claim to reduce spasticity following stroke are drug interventions, passive stretching, Electrical stimulation, cryotherapy, TENS, Constraint Induced Movement Therapy, Task specific practice, Neuro Developmental Therapy approaches, splinting and different positioning devices[15-17]. Cryotherapy is the therapeutic use of topical cold (ice packs or wraps) in reducing pathological muscle tone. It decreases tendon reflex excitability and clonus and slows down the conduction of impulses in nerves and muscles. Inhibition of hyper tonicity or pain is the goal for the use of cryotherapy methods. Clinically a variety of deficits are possible including changes in the level of consciousness

and impairment of sensory, motor, cognitive, perception and language functions[18,19]. Improving the rehabilitation outcome of the upper limb in stroke patients has been an ongoing challenge to the rehabilitation specialty.

More than 20 years ago, Bach-y-Rita[20] summarized the potential for new approaches in rehabilitation based upon laboratory studies of brain plasticity[21]. Physiotherapy in the rehabilitation of stroke patients is represented by various approaches. There is a general opinion that physiotherapy improves the function of stroke patients but the benefits seem to be statistically small and limited[22-24]. Treatment of hemiplegia from vascular insult is controversial, various treatment methods has been devised and advocated. Recent scientific theories have changed the focus of treatment from one of inhibition of abnormal tone and facilitation of normal movement to re-education of controls and functional retraining [25].

In the recovery stage spasticity causes altered limb positions there by muscle weakness and loss of functional activities .so the study aims to reduce the spasticity by various means and try to improve the voluntary activities in the limbs with the use of therapeutic exercises. Even though we have lots of methods to reduce spasticity here we have taken two physical therapy agents to reduce the forearm flexors spasticity among stoke patients to compare the efficiency of the two. Objective of the study is to evaluate and compare the effectiveness of neuromuscular electrical stimulation (NMES) and Cryotherapy in the management of spasticity in elbow flexors among stroke patients thereby improving hand function.

MATERIALS & METHODS

Participants

Study consists of (n=30) subjects, these all subjects were 3 weeks post-stroke after through assessment and qualifying the inclusion criteria subjects were included in the Study. Study was conducted in the physiotherapy out-patient department, Co-Operative institute of health sciences, Kerala, India. Per inclusion criteria, subjects were between 48 to 78 years of age and 23 of them are male and 7 of them are female. According to the classification of stroke, 17 of the subjects were ischemic stroke and 13 of them are of hemorrhagic stroke cases, according to the side affected 23 of them are right side stroke and 7 of them with left sided. Subject with stroke (hemiplegia), stages 3 and 4 according to the classification of recovery from stroke by Brunnstrom. Thus this study was carried out during sub-acute rehabilitation phase after 3–5 weeks post-CVA. Subjects with exclusion criteria: Hemiparesis(Sensory impairments),any other associated neurological disorders, Subject with any fixed deformities, Patient who underwent any recent orthopedic surgeries, Patients with severe respiratory distress and cardiac involvement, Subjects with intracranial tumors, Any recent musculo-skeletal pathology (Shoulder dislocation) were excluded from the study .Prior to participating in any study-related sequences the treatment procedures and details were clearly made understood by the participants/participants caretakers and later made sign on consent form .

Experimental Design

An Experimental designs was used in this study. Initially participants completed a socio-demographic questionnaire; following 30 subjects were assigned in to two groups by a purposive random sampling method – Group A and Group B. Group A: Consists of 15 subjects of spastic hemiplegia to be treated by antagonist neuromuscular electrical stimulation and re-education exercises. Group B: Consists of 15 subjects of spastic hemiplegia to be treated by cryotherapy and re-education exercises.

Interventions

Group A were treated by antagonist neuromuscular electrical stimulation and re-education exercises and another group B were treated with cryotherapy and re-education exercises. Before starting the treatment both the groups were evaluated for spasticity using the modified Asworth scale and the functional ability of the wrist and hand component using Fugl-Meyer post stroke assessment of physical performance ,thereby pre-test values were collected. The subjects were treated alternate days, (one day rest and one day treatment) for a period of 3 months duration. For Neuro muscular electrical stimulation (NMES), placement of electrodes were Active electrode in the muscle motor point (wrist extensors) and inactive electrode in the common extensors origin (Lateral Epicondyle of humerus) with faradic type current for 45 contraction of muscles with sufficient amplitude applied to evoke a (Rheobase) maximum contraction. In case of Cryotherapy **(**Ice massage (slow Icing)), which is applied over the spastic muscles (wrist flexors) for 15 minutes and free exercises, which can be performed by the patient by their own without any assistant. These exercises are thought to the patients and they actively perform the exercise which includes Wrist extension grasping a ball, Wrist flexion, Fingers extension, Supination of hand, Fingers flexion, Pronation of hand were included.

Data Analysis

All data were cleaned and arranged for analyzing, Using SPSS 16.0 for Windows (SPSS Inc, Chicago, IL) at a type I error rate of 0.05 were used for the study. Descriptive statistics were generated for the demographic, type of stroke, stroke affected side and associated disorders and to analyze the significant change in pre & post test value for reduction of spasticity and increase in Voluntary control hand and Voluntary control wrist in samples .The data were investigated by testing for group-by-time interactions for first spasticity, Voluntary control hand and Voluntary control wrist by the independent variable. The reading for the 1st sitting (pre-test) means and after 3 months of duration (post-test) values were analyzed by the help of SPSS using the student‘t’ test.

RESULTS

A total (n=30) subjects were included in the study, these 30 subjects were divided in two groups, Group A and Group B. Group A: Consists of 15 subjects ,4 Females and 11 male with spastic hemiplegia treated by antagonist neuromuscular electrical stimulation and re-education exercises. Group B: Consists of 15 subjects, 7 female and 8 males of spastic hemiplegia treated by cryotherapy and re-education exercises (Table-1).

TABLE 1: Percentage frequency of various parameters in group A &B related to stroke.

S.No	Variables		Group A(n=15)		Group B (n=15)	
			Frequency	Percentage	Frequency	Percentage
1.	Sex	Female	4	13.3	7	46.7
		Male	11	36.7	8	53.3
2.	Age	48-58	5	16.7	2	13.3
		59-68	8	26.7	6	40
		69-78	2	6.7	7	46.6
3.	Stroke affected side	Right	10	33.3	13	86.7
		Left	5	16.7	2	13.3
4.	Type of stroke	Hemorrhagic	7	23.3	6	40.0
		Ischemic	8	26.7	9	60.0
5.	Associated disorder	DM	4	13.3	1	6.7
		HTN	3	10.0	4	26.7
		DM+HTN	7	23.3	8	53.3
		Others	1	3.3	2	13.3

Using statistical analysis paired‘t’ test in the recorded data (t =8.315, df = 0.621) the result of pre-test and post-test showed statistical significance at p >0.005 level, unpaired‘t’ test in recorded data (t = 2.756, df = 29) the result showed there is significant difference in group A , with reference to spasticity, ‘t’value is 8.32(P<0.005), with reference to functional ability of hand,’ t’value is 11.30(<0.005) ,with reference to functional ability of wrist,’t’value is 11.29(<0.005)respectively therefore, this indicates there is reductive in spasticity and improvement in hand and wrist function when treated by neuromuscular electrical stimulation and re-education exercises in group A(Table-2).

TABLE: 2 Comparative mean value, mean difference standard deviation and ‘t’ value between pre Vs post test of spasticity, functional ability of hand and wrist in group A.

S.No.	Variables (Group A)	Values			Paired ‘t’
	Spasticity	Mean	Mean difference	S.D	value
1.	Pre-test	2.53	1.33	0.6210	8.3152
2.	Post-test	1.2			
	Hand function				
3.	Pre-test	5.4	1.73	0.5940	11.3011
4.	Post-test	7.13			
	Wrist function				
5.	Pre test	3.6	1.86	0.6403	11.2902
6.	Post test	5.46			

With regards to group B, Using paired‘t’ test in the data (t = 8.29, df = 0.560) the result of pre-test and post-test value showed statistical significance at p >0.005 level, ‘t’value for spasticity is 8.29(P<0.005), with reference to functional ability of hand,’t’value is 10.45(<0.005), with reference to functional ability of wrist,’t’value is 10.31(<0.005). Therefore, this indicates when treated by cryotherapy and re-education exercises there is reductive in spasticity and improvement in hand and wrist function of subjects in group B (Table-3).

TABLE 3: Comparative mean value, mean difference standard deviation and ‘t’ value between pre Vs post test of spasticity, functional ability of hand and wrist in group B.

S.No.	Variable(Group-B)	Values			Paired ‘t’
	Spasticity	Mean	Mean difference	S.D	value
1.	Pre-test	2.53	1.20	0.5606	8.29
2.	Post-test	1.33			
	Hand function				
3.	Pre-test	5.13	1.67	0.6175	10.4526
4.	Post-test	6.8			
	Wrist function				
5.	Pre test	4.13	1.80	0.6761	10.3109
6.	Post test	5.46			

Comparing the result of Group A and Group B , it was detected both had a significant effect almost similarly as for their application was considered in reducing spasticity and functional ability of hand and wrist among stroke patients .The unpaired ‘t’test shows the comparative effect of both the groups. The comparative ‘t’value for Group A and Group B in treating spasticity, functional ability of hand and wrist are respectively 0.603, 0.316,

0.249. The calculated‘t’value when compared with ‘t’table value 2.756 found to be less significant. This shows that there is no significant difference between the variables (Table-4).

TABLE 4: Comparative mean value, mean difference standard deviation and unpaired’ values of spasticity, functional ability of hand and wrist between group A and group B.

S.No.	Variable	Values			Unpaired ‘t’ value
	Spasticity	Mean	Mean difference	S.D	
1.	Group A	1.33	0.13	0.5895	0.6039
2.	Group B	1.2			
	Hand function				
3.	Group A	1.73	0.7	0.6055	0.3165
4.	Group B	1.66			
	Wrist function	Mean	Mean difference	S.D	
5.	Group A	1.86	0.06	0.658	0.2497
6.	Group B	1.8			

This suggests that stroke survivors treated with neuromuscular electrical stimulation and re-education (group A) have significant improvement in hand & wrist function along with reduction of spasticity, in other hand patients treated with cryotherapy and re-education exercises there (group B) have the same result, but when compared with reach other interventions there is significant changes statistically. Hence, it can be interpreted that both these interventions can be used interchangeably for treating the patients with stroke to reduce spasticity and to improve voluntary activities, as there is no significant difference in effects, exits between them.

DISCUSSION

In this study the main focus is on reduction of spasticity and improvement of voluntary hand and wrist control in post stroke survivors with help of neuromuscular electrical stimulation (NMES) and cryotherapy and to find which one is more effective in doing so. After 3 months of treatment the results, showed a reduction of spasticity and improvement of voluntary hand and wrist control in both the groups. This result is in line with a Meta analysis randomized controlled trials conducted on Functional electrical stimulation in post-stroke rehabilitation, carried out a study to explore the effect of neuromuscular electrical stimulation in reducing forearm flexors spasticity in hemiplegic patients[26]. The results showed that the flexion contractures were prevented in the group of patients of the wrist and fingers. In another study which claims Electro stimulation triggers a sensitive feedback which, when coupled with repetitive movements, induces a synaptic long term potentiation. And the enhanced cortical excitability facilitates the motor learning. The results showed that the flexion contractures were prevented in the group of patients of the wrist and fingers[27,28]. Further study suggests Using electro stimulation to facilitate the opening of the hand during grasp and release exercises would optimize the functional improvements obtained with classical rehabilitation training (without electro stimulation)[29,30,31,32].This all study supports the fact that electrical stimulation is very modalities in physiotherapy in improving hand function among stroke survivors In this study there cryotherapy was used for 15 patients with stroke along with re-education exercises, which shows significant changes in the reduction of spasticity and improvement of hand functions. Cryotherapy is the therapeutic use of topical cold (ice packs or wraps) in reducing pathological muscle tone. It decreases tendon reflex excitability and clonus and slows down the conduction of impulses in nerves and muscles. Inhibition of hyper tonicity or pain is the goal for the use of cryotherapy methods [33]. This indicates that cryotherapy is very effective in reducing spasticity and improving hand function in post-stroke survivors. But in this study neuromuscular electrical stimulation and cryotherapy found to be effective in reducing spasticity and to improve voluntary control of hand and wrist, but as there is no significant difference when compared between interventions. This indicates both physiotherapy practice can be used interchangeably for treating the survivors with stroke.

CONCLUSION

When compared two physical therapy treatment modalities namely neuromuscular stimulation and cryotherapy along active free exercises, because both are having some theoretical mechanism of action and also having same aim that is to reduce spasticity and there by helps in improvement of voluntary control.

Finally reduction of spasticity and improvement of voluntary hand and wrist control in post stroke survivors with help of neuromuscular electrical stimulation (NMES) and cryotherapy was achieved after 3 months of treatment sessions in both the groups. In each groups the treatment is statistically significant, which brings to a conclusion that both the treatment modalities (Neuromuscular electrical stimulation and cryotherapy) have been effective for both the groups, but comparatively there is no significant difference between the interventions. Hence, these two physiotherapy modalities are most effective treatment in stroke survivors.

RECOMMENDATIONS

1. It is highly recommended that physiotherapists should use cryotherapy or NMES to reduce spasticity and improve voluntary hand and wrist control in post stroke survivors.
2. It is recommended for further studies in this regard should also in corporate rules of active free exercises and thereby enhancing the outcome.

3. For further studies it is recommended that selection of the patient with specific category might produce more consistent and more appropriate level of functional outcome.

ACKNOWLEDGMENT
Authors are grateful to Co-operative Institute of Health sciences for providing the opportunity for conducting the research. The Authors acknowledge the all the staff of department of physiotherapy for providing the help and support.

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ABBREVIATIONS

1. CVA- Cerebrovascular accident
2. ICMR- Indian Council of Medical Research
3. NMES- Neuro muscular electrical Stimulation
4. SPSS- Statistical Package for Social Science
5. TENS- Trans Electrical Nerve Stimulation
6. WHO- World Health Organization