Effect of Air-Splint Pressure on Functional Activity of Elbow Joint in Stroke Patient

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ABSTRACT

Thirty male patients having stroke participated in this study. The purpose of this study was to find out the effects of air-splint pressure on the functional activity of elbow joint in stroke patient. All the patients were randomly divided into two equal groups. The first group was treated by air-splint pressure in conjunction with proprioceptive neuromuscular facilitation technique. The second group was treated by proprioceptive neuromuscular facilitation technique only. All patients were treated for five weeks, three days/week, and were evaluated twice at the beginning and at the end of the treatment program in terms of measuring the rang of motion of the affected elbow joint for all patients of both groups. Although, there was a statistically significant improvement of both groups at α 0.05 level of significance, but there was no a statistically significant difference between the first and second groups at same level of significance. There was more improvement in favor of the first group. These results proved evidence that air-splint pressure is a valuable physical therapy modality which should be used as an adjunct to other therapeutic modalities to achieve the optimum results in improving the functional activity of the affected joints.

INTRODUCTION

Burke[3] mentioned that upper motor neuron syndrome has either positive or negative features. Positive features as spasticity; abnormal posture and exaggeration of some extroceptive reflexes, while negative features as weakness and loss of dexterity, particularly fine manual manipulation. He also pointed out that the major defects in upper motor neuron lesion are negative and not positive[3]. Hinderer[8] pointed out that spasticity is used often to describe symptoms which arise secondary to upper motor neuron lesions resulting from a wide variety of neurological conditions including spinal cord injury.

On the other hand, Johnstone[9] mentioned that the altered muscle tone and sensory loss are the main problems to reach a high standard of rehabilitation of the stroke patients; through gaining inhibitory control over abnormal patterns. Also spasticity could be the cause of secondary problems as contractures[4]. Johnstone[9] also stated that, if a way could be found to divert the tonal overflow into the low tonal pattern it will become a vital factor in successful stroke rehabilitation. He also mentioned that the orally inflatable pressure splint is one of the valuable tools that may be used to maintain inhibiting positions and give the limb stability during rehabilitation sessions. Johnstone[9] mentioned that the

pressure splint is of a good value when it is orally inflated, because the warm air moulds the plastic to the limb and human lung will not over inflate above the maximum pressure of 40 mmHg. This orally inflatable splint give both patient and physiotherapist freedom to perform valuable exercise routines. Robichaud[11] concluded that air splint pressure application may be useful when a temporary decrease in muscle reflex activity is a therapeutic goal.

Diamond & Ottenbacher[7] reported that, after studying the effects of ankle-foot orthosis on hemiplegic gait, there was a significant improvement in step length, stance time and walking velocity

MATERIAL AND METHODS

Subjects:

Thirty male volunteers having stroke participated in this study. They were randomly divided into two equal groups. The age of the first group ranged between 44 and 62 years with a mean value of 51±6.3 years, while the age of second group ranged between 42 and 62 years with a mean value of 54±6.6 years. All patients were having moderate spasticity according to Ashworth[1] scale.

Instrumentation:

1. Pressure air-splint for elbow joint.
2. Video camera.
3. Video tape.
4. Video recorder/player.
5. Television.
6. Wooden stool, short legged 40 cm height.
7. Wooden exercise plinth [200 cm length, 80 cm width and 40 cm height].

Methods:

A) Evaluation:

Each patient was evaluated twice, prior to the treatment session and at the end of the treatment program, in terms of measuring range of motion of the affected elbow joint. Each patient assumed the supine lying position on the wooden plinth, then the investigator stick - to the affected elbow of each patient of the two groups - three reflectable marks, one on the elbow joint articulation, one five cm above and one five cm below the articulation along the lateral aspect of the affected arm and forearm. The patient was then asked to do the maximum available functional range of motion - of his affected elbow - ranged between maximum extension and maximum flexion three times. At the end of treatment, each patient was asked again to do the same movement - maximum flexion to maximum extension of the affected elbow - three times, then by the video camera this movement was recorded for each patient before and after treatment. After recording the tape was played back on the video/player connected to a television. The range of motion of the affected elbow for each patient was recorded from the fixed picture on the television screen through a transparent paper fixed on the screen. At the end of this recording a comparison was done between the range of motion of the same affected elbow joint before and after treatment.

B) Treatment:

Each patient assumed the sitting position on the wooden stool, and the treatment was given by the same physiotherapist three days weekly, for five weeks with an average of 30 minutes per session for the first group and 15 minutes for the second group.

Each treatment session consisted of:

- In case of the first group:

Fifteen minutes of pressure splint, which was applied to the affected elbow joint musculatures followed by 15 minutes of proprioceptive neuromuscular facilitation (PNF) patterns, five minutes after deflation of the air-splint, with two minutes rest in between the patterns of PNF.

- In case of the second group:

Proprioceptive neuromuscular facilitation patterns for 15 minutes to the affected elbow joint, also with two minutes rest in between the patterns of PNF.

The technique of using the pressure splint in the treatment:

The patient was allowed to put on a suitable dressing to make his evaluation and treatment easy. The patient was positioned in the supine lying comfortably on the wooden plinth, then the pressure splint was applied by the investigators to the elbow joint and then orally inflated to reach 40 mmHg- pressure and was kept for 15 minutes, after which it was deflated and then taken off.

The technique of applying the proprioceptive neuromuscular facilitation patterns

Each patient was seated on the wooden stool and the physiotherapist stood beside the affected arm and applied the following two patterns with more emphasis on the elbow joint musculatures:

1. Extension-abduction-internal rotation with extended elbow. And
2. Flexion-adduction-external rotation with flexed elbow.

RESULTS

General characteristics of subjects:

The general characteristics of subjects in both groups are presented in table (1). Inspection of this table revealed that both groups were almost matched regarding the age and duration of illness.

Table (1): General characteristics of subjects of both groups.

Subject No.	First group		Second Group	
	Age (years)	Duration of illness (month)	Age (years)	Duration of illness (month)
1	62	20	60	18
2	57	16	56	15
3	52	13	54	14
4	54	15	50	12
5	46	15	62	20
6	53	18	63	21
7	46	10	58	17
8	48	12	59	17
9	60	18	49	16
10	47	12	44	10
11	44	10	48	14
12	56	17	60	18
13	40	8	52	15
14	45	15	42	12
15	48	17	58	16
Mean	51	14	54	16
S.D.	±6.3	±3.5	±6.6	±2.9

S.D. : Standard Deviation.

Measurement of elbow range of motion (ROM):

The mean value of measurement of elbow ROM before and after five weeks of treatment is presented in table (2) and illustrated in figure (1) for the first group, and table (3) & figure (2) for the second group. Inspection of table (2) & figure (1) revealed that the mean value of ROM of the group increased from 46 to 101 degrees with a percentage of 116%. The increment was statistically significant at α 0.05. Inspection of

table (3) & figure (2) revealed that the mean value of ROM of the second group increased from 48 to 90 degrees with a percentage of 93%. The increment was statistically significant at α 0.05. In both groups marked increase in ROM was especially found in all patients with shorter duration of stroke (five patients from the first group and three patients from the second group) (table 1). Inspection of table (2) and table (3) revealed that there was increase in the ROM of both groups with more increase in the ROM of the first group over the second group, where the percentage of increment in the first group was 116%, while that of the second group was 93%. However, there was no statistically significant difference between the first and second groups at α 0.05 level of significance.

Table (2): The mean value of elbow range of motion of the first group.

Statistics	Value of elbow range of motion in degrees			
	Before treatment	After treatment	Mean difference	Percentage Of change
Mean	46	101	55	116%
S.D.	±6.3	±7.6	±4.9*	±16.3

* : Significant at α 0.05

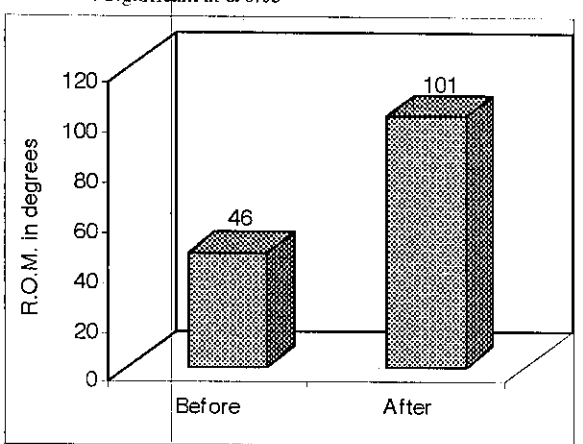

Fig. (1): The mean values of elbow range of motion before and after treatment of the first group.

Table (3): The mean value of elbow range of motion of the second group.

Statistics	Value of elbow range of motion in degrees			
	Before treatment	After treatment	Mean difference	Percentage of change
Mean	48	90	43	93
S.D.	±7.5	±4.9	±4.4*	±24.6

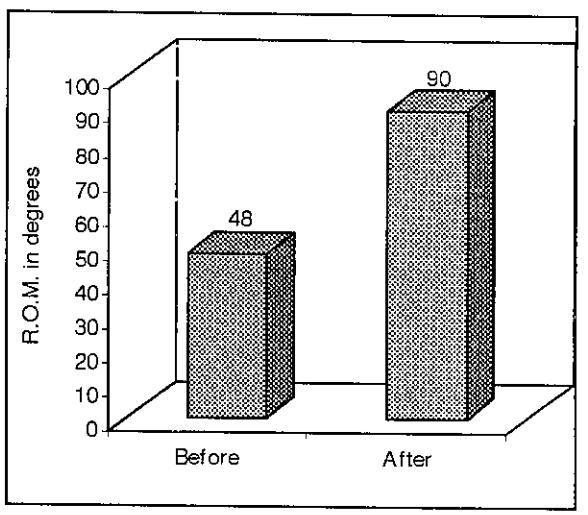

Fig. (2): The mean values of elbow range of motion before and after treatment of the second group.

DISCUSSION

The pressure splint in conjunction with proprioceptive neuromuscular facilitation patterns (PNF) which were used in the treatment of the first group, and proprioceptive neuromuscular facilitation techniques only which were used in the treatment of the second group, produced a significant increment in the elbow ROM of all patients of both groups, who had stroke. However, the pressure splint in conjunction with PNF which were used in the treatment of the first group led to more improvement over the proprioceptive neuromuscular facilitation patterns only which were used in the treatment of the second

group. These results appear to justify the opinions regarding the effectiveness of pressure splint reported by Johnstone [9] who mentioned that it will become a vital factor in successful rehabilitation; if a way can be found to divert the tonal overflow into the low tonal pattern. He also mentioned that the orally inflatable pressure splint is one of the valuable tools that may be used to maintain inhibiting positions and to give both upper and/or lower limbs stability during rehabilitation sessions[9]. Cusick & Sussman[6] reported that the orally inflatable splint give both patient and physiotherapist freedom to perform valuable exercise routines. Lehmann [10] stated that gait speed was significantly increased in both dorsi and plantar flexion and it was more significant in dorsiflexion, with using the ankle-foot orthosis. Burdett [2] concluded also that there was no significant difference between plastic and metal ankle-foot orthosis in improving the gait. Diamond & Ottenbacher [7] concluded that the use of ankle-foot orthosis or tone-inhibiting dynamic ankle-foot orthosis results in a significant improvement in walking velocity, step length, and stance time on the hemiparatic limb, and a significant decrease in cadence. Cowland[5] mentioned that their study theoretically supports treatment efforts aiming at improving motor neuron recruitment rather than reducing the upper limb function in the stroke patients. Robichaud & Agostinucci[13] reported that air-splint circumferential pressure applied to the lower leg decreased soleus alpha motor neuron reflex excitability in subjects with spinal cord injury. Robichaud [12] mentioned that cutaneous stimulation caused by an inflated air-splint has been demonstrated to have long-lasting effects on motor neuron reflex excitability. Also Robichaud [12] stated that the clinician who use air-splints to promote joint stability should be aware that they may actually be inhibiting the activity of muscles encompassed by the air-splint. Also Leone & Kukulka[11] pointed out that tendon pressure whether on upper or lower limb muscles should be an effective means for producing a reduction of tone in the hypertonic muscles of hemiparetic patients. On the other hand, Voss et al.[14] reported that PNF patterns have direct effect on improving the motoneuron recruitment of the affected muscles. Also they mentioned that through the proper positioning of the patient during the application of PNF patterns, certain factors will contribute to the ease of performance and procedures will become more effective as follows: **a-** Tone will be enhanced through the tonic labyrinthine reflex. **b-** Manual contacts with the trained limb will provide appropriate sensory input through pressure over the agonistic muscle groups rather than the antagonistic ones. **c-** Stretch can be used to increase response more adequately. **d-** Resistance can be used to strengthen the response beside recruiting more motor units.

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الملخص العربي

تأثير الجبيرة الهوائية الضاغطة على الأداء الوظيفي لمفصل الكوع في مرضى الشلل النصفي الطولي

شارك في هذه الدراسة ثلاثون مريضا يعانون من الشلل النصفي الطولي بهدف دراسة أثر الجبيرة الهوائية الضاغطة على الأداء الوظيفي لمفصل الكوع في مرضى الشلل النصفي الطولي ، تم تقسيم جميع المرضى عشوائيا إلى مجموعتين متساويتين. تم علاج المجموعة الأولى بواسطة الجبيرة الهوائية الضاغطة بالإضافة إلى التسهيل العضلي العصبي الإستقبالي ، بينما تم علاج المجموعة الثانية بالتسهيل العضلي الإستقبالي فقط ، كانت مدة العلاج لكلا المجموعتين خمسة أسابيع بمعدل ثلاثة أيام أسبوعيا. تم تقييم جميع المرضى مرتين، مرة قبل بداية العلاج والمرة الثانية في نهاية العلاج عن طريق قياس المدى الحركي لمفصل الكوع المصاب، وفى نهاية الدراسة تم مقارنة نتائج التقيمين إحصائيا. وبالرغم من التقدم الإيجابي الذي حدث لجميع مرضى المجموعتين إلا أن تقدم المجموعة الأولى لم يكن إيجابيا بالنسبة للمجموعة الثانية، وهذه النتائج تدل على أن للجبيرة الهوائية الضاغطة قيمة وذات فائدة في تحسين الأداء الوظيفي لمفصل الكوع لمرضى الشلل النصفي الطولي ويجب أن تستخدم مع وسائل علاجية أخرى لكي تعطى أفضل النتائج.