Lower Limb Spasticity Control in Response to Cryotherapy and Wrapping Technique in Hemiplegic Children

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ABSTRACT

The present study was conducted to determine the effect of cryotherapy and wrapping technique, in addition to a designed physical therapy program, on controlling lower limb spasticity in hemiplegic cerebral palsy. ***Subjects:*** *Thirty hemiplegic cerebral palsied children (9 right side and 21 left side) ranging in age from six to eight years represented the sample of this study. They were selected from the out-patient clinic of the Faculty of Physical Therapy, Cairo University. The degree of spasticity ranged from mild to moderate grades according to the modified Ashworth scale. The lower limb was free from any structural deformities. Children were divided randomly into two groups of equal number A (control) and B (study).* ***Procedures:*** *Double blind evaluation to determine H/M ratio and anterior tibial muscle strength (ATMS) was conducted for each child of the two groups, before and after three months of treatment. Group A (control) received a specially designed exercise program, while group B (study) received cryotherapy, followed by wrapping technique, in addition to the exercise program given to group A.* ***Results:*** *The results revealed, no significant differences when comparing the pre-treatment mean values of the two groups. Significant improvement was observed in all the measuring variables of the two groups (A and B), when comparing their pre and post-treatment mean values. Significant improvement was also observed when comparing the post-treatment results of the two groups in favor of group B.* ***Conclusion and Discussion:*** *Improvement of H/M ratio and ATMS may be attributed to the combined effects of cryotherapy and wrapping, in addition to the designed exercise program, in controlling spasticity of the affected lower limb and so, improving its functional activities.*

Key words: *Cryotherapy, Wrapping Technique, Hemiplegic Cerebral Palsy.*

INTRODUCTION

Cerebral palsy is a physical impairment that affects the development of movement[1]. It has been defined as a non-progressing encephalopathic injury or lesion to the developing brain. The affected children present with abnormal muscle tone and varying movement disorders[2].

Hemiplegia is one of the commonest forms of cerebral palsy. In such cases suspicion falls on genetic causes or prenatal events, as infection or vascular occlusion, occurring before birth. Perinatal factors as birth injury seem to predominate. The post natal events include viral and bacterial meningitis or encephalitis, head injury, epilepsy and cardiovascular accidents[3].

The manifestations of hemiplegic children are variable including motor deficits, sensory disturbances, perceptual impairments, functional limitation and balance difficulties[4].

Planter flexion deformity is a common finding in hemiplegic children, resulting from spasticity[5]. In such cases, increased motoneurone excitability has postulated to be a contributing factor in causing spasticity[6]. This leads to excessive activity in muscle groups as wrist flexors and ankle planter flexors[7].

It has been reported that therapeutic modalities used to reduce motoneurone

excitability may have potentials for maintaining muscle length changes in neurologically impaired patients[8].

Sustained cutaneous stimuli have been used to reduce spasticity. Sustained ice application, wrapping cold towels, using cryogel packs around a spastic body part or applying cold compressors are frequently used[9]. Manual therapy is also of a great value in increasing circulation and improving muscle tone[10]. Application of inflatable plastic pressure splint to the entire extremity serves to reduce spasticity and promote sensory stimulation[11].

Heat application has also been used for damping muscle tone and reducing spasticity of the body part[12].

This study is a trial conducted to determine the combined effects of prolonged cold application via using cryogel packs, and wrapping technique on controlling spasticity of the lower limb in hemiplegic children.

SUBJECTS, INSTRUMENTATION AND PROCEDURES

Subjects

Thirty hemiplegic cerebral palsied children (9 right side and 21 left side), ranging in age from 6 to 8 years, represented the sample of this study. They were selected from the out-patient clinic of the Faculty of Physical Therapy, Cairo University. They had minimal non-significant perceptual defects and were able to follow instructions given to them. They were free from any associated disorders other than spasticity. The degree of spasticity ranged from mild to moderate grades according to the modified Ashworth scale [(13)]. The involved lower limb was free from any structural deformities; however, children demonstrated variable degrees of tightness of hip adductors, hamstrings and tendo Achilles muscles. Children were divided randomly into two groups of equal number (A and B). Double blind evaluation was conducted for each child individually before and after three months of treatment. Group A (control) received a specially designed physical therapy program, while group B (study) received cryotherapy followed by wrapping technique for the affected lower limb, in addition to the same designed exercise program given to group A.

Instrumentation

I-For evaluation

1- A computerized electromyographic apparatus (Diza 2380) was used to determine the H/M ratio.

2- Electronic muscle tester (Tensiometer): It is a hand-held muscle tester that is composed of a microprocessor. (Model 011163 Lafayette electronic muscle tester system EMT)

II- For treatment

1- Tumble forms (mat, wedges, rollers and balls) from Preston, for the application of the exercise program.

2- Cryogel packs were used to inhibit extensor spasticity of the lower limb muscle.

3- Three, 10 cm. elastic wrap bandages.

Procedures

I-For evaluation

Double blind evaluation for each child in the two groups was conducted in a warm, well lighted and quiet room, before and after three months of treatment using electromyography to measure H/M ratio, and electronic muscle tester (EMT) to measure anterior tibial muscle strength (ATMS).

1- Hoffman reflex / Myogenic response (H/M) ratio: Surface electrodes were used for recording electromyographic signals from soleus muscles. Tibial nerve in poplitial fossa was used for stimulation. The active

electrode was placed two centimeters distal to the insertion of the gastrocnemius muscle, and the reference electrode was placed three centimeters distal to the active electrode[14,15]. Maximum Hoffman reflex and maximum Myogenic responses were recorded and H/M ratio was calculated to measure the motor neuron pool excitability which reflects the level of spasticity as an indication of central nervous system excitability[16].

2- *Anterior tibial muscle strength (ATMS):* From supine lying position with heels outside the plinth and the affected lower limb is slightly flexed at the knee. The electronic muscle tester (EMT) was attached to the dorsum surface of the affected foot. It was switched on, and then the reset button was pressed to clear the screen. The menu button was pressed to select kilograms. The test time was set to three seconds. Each child was then asked to dorsiflex his/her foot against maximum resistance provided by the physiotherapist while holding the EMT. The anterior tibial muscle strength was measured in kilograms. The test was performed for three times and the average was calculated.

II- For treatment

Group A (control)

Received a designed exercise program which was conducted daily for three successive months, including: Neurodevelopmental technique, proprioceptive training, facilitation of righting and equilibrium reactions, faradic stimulation on the antispastic muscles of the hemiparetic side, stretching exercise for the muscles liable to be tight, strengthening exercises for the antispastic muscles, and gait training in closed and open environment. Special attention was also given to the unaffected side and to the trunk.

Group B (study)

In addition to the designed physical therapy program given to the control group, the study group received ice application in the form of cryogel packs, wrapped in wet towels and fitted to cover the quadriceps and calf muscles of the affected lower limb. The elastic bandage was then wrapped around the lower limb from the distal phalanx of the toes to the hip. It was applied with precaution to prevent impedance of circulation. The cryogel packs continued for one hour, while wrapping existed for three hours. Subjects were free to move about.

RESULTS

The raw data of anterior tibial muscle strength (ATMS) and H/M ratio of the affected lower limb in spastic hemiplegic cerebral palsied children were statistically treated to determine the mean and standard deviation of each measuring variables, for the two groups before and after three months of treatment. Student t-test was then applied to examine the significance of treatment procedures conducted in each group.

The obtained results in this study revealed no significant differences when comparing the pre-treatment mean values of the two groups. Significant improvement was observed in all the measuring variables of the two groups (A and B), when comparing their pre and post-treatment mean values. However, high significant improvement was observed in group B, when comparing its post-treatment mean values with the post-treatment mean values of group A.

I- H/M ratio (Hoffman reflex / Myogenic response ratio)

As revealed from table (1) and figure (1), significant reduction was observed in the

mean value of H/M ratio in the control group (A) at the end of treatment as compared with the corresponding mean value before treatment (P<0.05), with a percentage of improvement of 23.88%.

Also, table (1) and figure (1), showed a significant reduction in the mean value of H/M ratio in the study group (B) at the end of treatment as compared with the corresponding mean value before treatment (P<0.0001), the percentage of improvement was 48.24 %.

Table (1): Pre and post-treatment mean values of H/M ratio (mV.) for groups A and B

	Group A (control)		Group B (study)	
	Pre	Post	Pre	Post
X`	0.83	0.67	0.85	0.44
± SD	± 0.12	± 0.163	± 0.22	± 0.13
t-test	3.062		6.214	
P-value	0 < 0.05		< 0.0001	
Sig.	Significant		Highly Significant	

X`: Mean SD: Standard deviation P-value: Level of significance Sig.: Significance

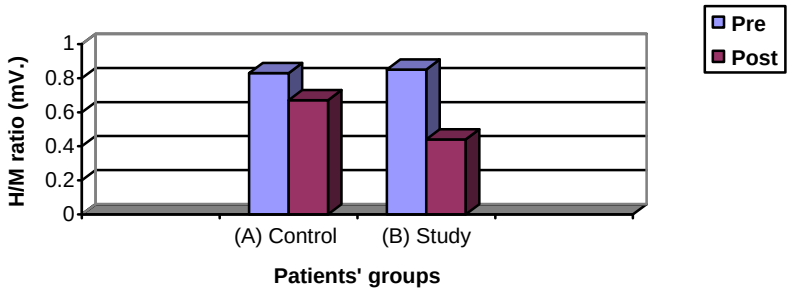

Fig. (1): Illustrating the pre and post-treatment mean values of H/M ratio (mV.) for groups A (control) and B (study).

Significant improvement was also observed when comparing the post-treatment mean values of H/M ratio of the two groups in favor of group B (P<0.05).

II- Anterior tibial muscle strength (ATMS)

As shown in table (2) and figure (2), significant increase was observed in the mean value of ATMS in the control group (A) at the end of treatment as compared with the corresponding mean value before treatment (P<0.01), with a percentage of improvement of 44.19 %.

Also, table (2) and figure (2), revealed a significant increase in the mean value of ATMS in the study group (B) at the end of treatment as compared with the corresponding mean value before treatment (P<0.0001), the percentage of improvement was 82.36 %**.**

Table (2): Pre and post-treatment mean values of ATMS (Kg.) for the two groups (A and B)

	Group A (control)		Group B (study)	
	Pre	Post	Pre	Post
X`	0.792	1.142	0.788	1.437
± SD	± 0.04	± 0.33	± 0.12	± 0.26
the-test	4.08		8.78	
P-value	0 < 0.01		< 0.0001	
Sig.	Significant		Highly Significant	

X`: Mean SD: Standard deviation P-value: Level of significance Sig.: Significance

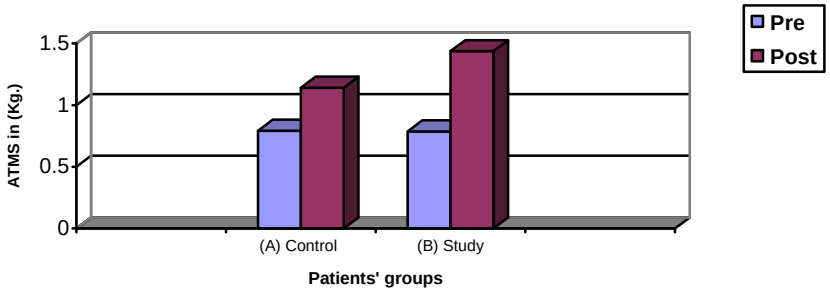

Fig. (2): Representing the pre and post-treatment mean values of ATMS (Kg.) for the two groups A (control) and B (study).

Significant improvement was also observed when comparing the post-treatment mean values of ATMS of the two groups in favor of group B ($p<0.05$).

DISCUSSION

Spasticity is characterized by disharmony of muscle movements brought on by hyperactivity of the stretch reflex and hypertonicity of the antigravity muscles[17].

Foot drop and inadequate heel strike were evident in hemiplegic children, which were attributed to extensor mass synergy pattern[18].

One of the common and serious problems which occur as a result of spasticity in hemiplegic cerebral palsy is the development of contractures or tightening of the adductors, hamstrings and tendo Achilles, which in turn interferes with performance of functional activities[19].

The purpose of this study was to determine the combined effects of cryotherapy and wrapping technique on controlling lower limb spasticity in hemiplegic cerebral palsy.

The results of the study, after the suggested period of treatment, revealed statistically significant reduction in the mean values of H/M ratio and significant increase in the anterior tibial muscle strength.

The results of this study confirm the findings of Lehman and De lateur[20] who reported that cold application has been found useful to be used to reduce spasticity in upper motor neuron lesion and in muscle re-education to facilitate muscle contraction.

Lemons et al.,[21] reported that, ice can reduce motor nerve conduction velocity. In management of spasticity cold application can decrease tendon reflex excitability and clonus, increase range of motion of the joints and improve power of the antagonistic muscle group.

The post-treatment results agree with Price et al,[22] who established that cryotherapy has an effect on reducing the path length, a parameter indicating the frequency dependent visco elastic response at the ankle. High values of path length have been shown to be associated with the presence of spasticity. They recommended the use of cryotherapy for one hour on the calf muscles aiming for spasticity reduction.

The study also agrees with Price and Lehman[23] who reported temporary reduction of spasticity with ice application. They added that, cryotherapy may be of a value in preparing the spastic patient for subsequent therapeutic e.g. joint ranging, stretching and gait training, provided that the physical therapy was performed immediately following cryotherapy.

The results of the study support the findings of Warren et al.,[24] who concluded that

deep prolonged and penetrating cold could be used in therapy to induce relaxation. They attributed their findings to be due to lowering of the back ground level of stretch afferent input. They reported that, deep cold (penetrating the muscle mass) produces cold block of the receptors or the afferent fibers themselves.

Wrapping in the present study produced maintained pressure, induced warmth and preserved warmth that resulted from prolonged icing.

Combination of these two inhibitory techniques gave a better chance for other facilitatory techniques to improve the active range of ankle joint and strength of anterior tibial muscle group, so, improved the functional activities of the spastic lower limb.

Susan et al,[25] stated that inhibition occurring due to the use of cryotherapy may be due to the local cooling effect on every component of the segmental sensorimotor complex, including large afferent fibers of muscle spindles (both alpha and gamma motoneurons), all skin receptors, extrafusal muscle fibers and myoneural junction.

The results of the study also agree with Julie and James[26] who reported reduction in the soleus motoneurone reflex excitability after the application of an air-splint in patient with spinal cord injury. They concluded that, the mechanisms responsible for the decrease in motoneurone excitability following pressure application, are spinal in origin. They attributed their results to be due to cutaneous effects, in decreasing the amplitude of the soleus H-reflex. They also attributed changes in soleus H-reflex to be due to an increase in pre-synaptic inhibition of Ia afferents.

The results of the present study may also be attributed to the effect of cooling in reducing the intramuscular temperature, leading to a decrease in the discharge of the spindle afferent fibers and in-turn reducing the nerve conduction velocity. In addition, wrapping the skin produces warming that results in aphasic reduction in neural activity by the C non-myelinated fibers, which show a specificity to thermal stimulation.

These findings provided that C-fiber sensory receptors, which are located along the length of the lower extremity, generally in hairy skin, code the intensity and duration of pain, temperature and light touch[27]. They have a high threshold for depolarization and are slow to adapt after a lengthy discharge[28.] Wrapping therefore appeared to be an appropriate stimulus for C-fibers or non-specific free nerve endings on the skin that facilitates autonomic nervous system response, that in-turn decrease muscle tone.

Conclusion

From the results of the present study, it can be concluded that cryotherapy and wrapping technique may be used, in addition to other modalities, to control spasticity of the lower extremities in hemiplegic cerebral palsy.

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الملخص العربى

التحكم في تشنج الطرف السفلي كأستجابة لتأثير التبريد وتقنيةِ الربط في الأطفالِ المصابين بالفالج الشقي

أجريتْ الدراسة الحالية لتَقْرير تأثيرِ التبريد و تقنية الربطِ، بالأضافة إلى برنامجَ علاج طبيعي مصمّمَ ،وذلك للسَيْطَرَة على تشنج الطرفِ الأسفل في الشلل المخي. عينة البحث: ثلاثون طفلا مصابا بالفالج الشقي (تسعة جانب أيمنِ و أحدي وعشرون جانبِ أيسرِ) تَرَاوُح ت أعْمارِهم مِنْ ستّة إلى ثمان سَنَواتِ يُمثّلُون عيّنةَ هذه الدراسةِ. وقد إختاروا مِنْ العيادة الخارجيةِ مِنْ كليّةِ العلاجِ الطبيعي، جامعة القاهرة. وتَراوحتْ درجة التشنج مِنْ بسيط الي متوسط طبقاً لمِقيا س أشورث المُعَدَّل. الطرف الأ سفل كَانَ خالي من أيّ عاهات هيكلية. وقُسّموا الأطفال بشكل عشوائي إلى مجموعتان إثنان مِنْ مجموعاتِ العددِ المساوي: المجموعة الضابطة (أ) ومجموعة الدراسة(ب). طريقة البحث: تم تقييم نسبة إتش / إم وقوّةالمجموعة العضلية الأمامية للساق لكُلّ طفل بلمجموعتين، قَبلَ وَبَعد ثلاثة شهورِ مِنْ المعالجةِ. تلقت المجموعة (أ) برنامج علاج طبيعي مصمّم خصيصاً، بينم تلقت المجموعة (ب) العلاج بالتبريد ، تَلى بتقنيةِ الربطِ ، بالأضافة إلى برنامجَ العلاج الطبيعي الذي أعطىَ للمجموعة الأولي. النَتائِج: كَشفتْ النَتائِج انه لا إختلافاتَ ذات دلالة احصائية هامّةَ عندما تُقارنُ قِيَم المتوسط الحسابيَ قَبْلَ المعالجةَ مِنْ المجموعتين. اما التحسن الهامّ فقد لوحظَ في كُلّ متغيّراتِ قياس المجموعتين (أ) و(ب)، عندما تُقارنانِ قِيَمَهم قَبْلَ وما بَعْدَ المعالجةَ. ولوحظَ التحسن الهامّ أيضاً عند مُقارنُة نَتائِجَ ما بَعْدَ المعالجةَ مِنْ المجموعتين لمصلحة مجموعة الدراسة. المُناقشةِ:التحسن الملحوظ الذي حدث في المجموعة(ب) بنسبة إتش / إم وقوة العضلات الأمامية للساق قَدْ يُنْسَبانِ إلي التأثيراتِ المشتركةِ للعلاج بالتبريد مع الربط ، بالأضافة إلى برنامجَ العلاج الطبيعي المُصَمَّم، في السَيْطَرَة على التشنج للطرفِ الأسفل المتأثّرِ وهذا يُحسّنُ نشاطاتَه الوظيفيةَ.

الكلمات الدليلية: العلاج بالتبريد، تقنياتِ الربط، الفالج الشقي لدي الأطفال.