Inflatable Pressure Splint Combined with Neurodevelopmental Treatment: Effect on Spasticity and Balance in Diplegic Cerebral Palsied Children

Abeer Abo Bakr Elwishy, PT.D.[*], and Heba M. Youssr M. El-Basatiny, PT.D.[**]
* Department of Neuromuscular disorders and its surgery, Faculty of Physical Therapy, Cairo University.
** Department of physical therapy for Disturbance of Growth and Development in Children and its surgery, Faculty of Physical Therapy, Cairo University.

ABSTRACT

Thirty spastic diplegic cerebral palsied children of both sexes were included in this study in an attempt for determining the combined effect of inflatable pressure splint and neurodevelopmental therapy (NDT) on spasticity and balance in those children. Their age ranged from 8 to 13 years and they were randomly divided equally into two treatment groups: the study group (B) received NDT in conjunction with application of inflatable pressure splint. The control group (A) received the same program without inflatable pressure splint for 16 weeks (3 times/ week). Evaluation was done for stability index scores of balance by using Biodex system (at stability 8) and modified Ashworth scale (MAS) for quadriceps and planterflexors muscles of both lower limbs for all diplegic children before and after treatment. Although, results showed a statistically significant improvement in all tested variables in both groups (A&B) after treatment, there was a highly significant improvement in study group (B) after treatment. These results proved that inflatable pressure splint is a valuable physical therapy modality, which should be used as an adjunct to other therapeutic modalities (NDT) to reduce spasticity and balance control in spastic diplegic children.

INTRODUCTION

Cerebral palsy (CP) is a term used to describe a group of disorders of movement, muscle tone, or other features that reflect abnormal control over motor function by the central nervous system (CNS). It encompasses only those non-progressive or static lesions that affect the developing brain's control over motor abilities[30]. Spastic diplegia is the commonest form of CP as a result of injury to the periventricular leukomalacia ring, a temporal window of development that ends at 30-32 weeks. A characteristic feature of periventricular leukomalacia is the disruption of corticospinal axons, while the cortical pyramidal projection neurons are left intact and subsequently make aberrant intracortical axonal projections[25].

CP is the most common cause in childhood of the upper motor neuron syndrome, which has a number of positive and negative features. The positive features are spasticity, hyper-reflexia and co-contraction. The negative features are weakness, loss of selective motor control and deficits in balance and co-ordination[1].

A major impairment in CP is spasticity. Clinically the term spasticity is often used to refer to a number of impairments, including muscle hypertonia, hyperactive deep tendon reflexes, clonus and velocity-dependent resistance to passive stretch[17,21]. Many surgical[29] and theraputic[12] procedures are performed and many pharmacological drugs[28] are administered to children with CP to

minimize or eliminate the influence of spasticity.

Spasticity per se can be roughly quantified in the clinic with the modified Ashworth scale (MAS), a six-point measure of limb resistance to passive movement. The MAS has been widely used, it has the advantage of being simple to administer and is reproducible measure for determining the efficacy of an intervention[5,14].

Inhibition of spasticity is necessary to increase extremity mobilization, prevent postural abnormalities, provide independence in daily living activities and accelerate walking speed. Various methods including neurodevelopmental therapy (NDT), electrical stimulation, inhibitory orthosis and splints, biofeedback and cold application are also used for the inhibition of spasticity as well as approaches based on stimulation of skin receptors had also been used[11,12,19].

NDT exercise programs include facilitation of movement technique and automatic postural responses and controlling the influence of abnormal movement patterns. The various handling, positioning and movement techniques used in NDT have the advantage of using the child's own automatic responses[4,7,36].

The inflatable pressure splints can be used to control spasticity, increase stability, facilitate motor development and improve normal motor patterns in children with neurological problems[15,31]. Inflatable pressure splints were developed to support extremities in postures antagonistic to the spastic postures in the neurophysiological treatment approach[15].

Developmental studies of children with CP have documented delayed acquisition of motor skills. It has been suggested that many of these delays in developing complex motor skills such as independent stance and walking are due to poor balance. Balance, is defined as the ability to maintain equilibrium by positioning the centre of gravity over the base of support. The center of gravity is the body's center of mass and it changes according to changes in positions and movements of body segments[26]. Postural adjustments occur in order to maintain balance[16].

There are four principal contributing factors to poor balance control[3]. These factors include velocity dependant increase in tonic stretch reflexes (spasticity), muscle weakness, excessive coactivation of antagonist muscles and increased stiffness around joints. These factors reflect not only central nervous system differences but also mechanical changes in posture, typically a crouch stance in spastic diplegia[9]. Thus mechanical differences as well as central nervous system dysfunction are thought to contribute to the lack of balance in those children[8].

The aim of this study was to determine the combined effects of both NDT and inflatable pressure splint on spasticity of the lower limbs and balance in spastic diplegic children.

SUBJECTS MATERIALS AND METHODS

I- Subjects

Thirty spastic diplegic cerebral palsied children, from both sexes (17 boys and 13 girls), with age ranged from 8 to 13 years were selected from the out-patient clinic of faculty of Physical Therapy, Cairo University and National Institute of Neuromotor system. They were assigned randomly into two groups of equal number: control group (A) with a mean age of 9.9 + 2.3 years, 8 boys &7 girls and study group (B) with a mean age of 10.1 + 1.7 years, 9 boys & 6 girls.

All patients were selected according to following criteria:

1- degree of spasticity according to the modified Ashworth scale [5] ≥1+ .
2- able to understand and carryout verbal directions included in the test.
3- able to cooperate.
4- had no structural deformities in any joint of the lower limbs.
5- able to stand unassisted.
6- had neither visual nor auditory problems.
7- achieved score 1 according to clinical balance assessment scale[22].

The control group (A) received physical therapy program based on NDT approach only, three times per week for four months. The study group (B) received the same treatment modality as control group in addition to the application of an inflatable pressure splint 3 times/week for 4 months.

II- Materials

**** For evaluation:***

- Biodex Balance System:

(Biodex Medical system Inc, Shirley, New York, USA). The system consists of a movable balance platform, which can be set at variable degrees of instability. It allows for approximately 20 degrees of surface tilt from horizontal in all directions. The system is interfaced with computer software monitored through the control panel screen and connected with a printer. It allows for eight stability levels, where level one is the least stable and level eight is the most stable level. The system measures the subjects' ability to control the platform angle of tilt. The dependent measurement obtained from the Biodex system was the stability index (SI). The stability index represents the variance of platform displacement in degrees, from level, in all motions during the test. A high score is indicative of a lot of movements during the test, which indicates poor balance control.

- Modified Ashworth Scale:

For evaluating spasticity of the planterflexors & quadriceps muscles of both lower limbs for all diplegic children of both groups (A&B).

**** For treatment:***

- Inflatable pressure splint:

An inflatable pressure splint (Medi-source, Inc. USA) was used for spastic diplegic children in the study group (B) only. It provides circumferential pressure around the foot, lower leg and thigh. The splint is a double transparent plastic bag with anterior zipper.

III- Methods

1- Evaluation protocol

Each diplegic child in both (control& study) groups was assessed before and after the treatment program which lasted 4 months using:

a- Clinical scale (MAS): To assess the spasticity of quadriceps and planterflexors muscles of both sides. This was done by two examiners and the mean of the two readings were calculated.
b- Balance assessment (using the Biodex balance system):

The procedure was as following:

- Stability level "8" was choosen.
- Each child received a verbal explanation about the test steps.
- Each patient was asked to center himself/herself on foot platform before starting the test.
- Each child was asked to assume this position: standing on both feet with arms held at the sides & trying to control his/her balance as much as possible. Two test trials were performed before recording for the child to become familiar with test[23].

- Each child was then asked to keep the platform level for 20 seconds with double leg support[34] while focusing on a visual feedback screen directly in front of him/her in an attempt to maintain the cursor (which represents the center of the platform) at the center of the bullseye on the screen.

2- Treatment protocol

- A pretest- post test, two groups design was used in this study. The study group (B) received NDT in conjunction with inflatable pressure splint which is a long leg splint, 60cm in length, with the proximal end just below the inguinal area and the distal end at level of toes. It was applied over the entire leg and thigh. The pressure splint was orally inflated and applied bilaterally for 20 minutes, after which it was deflated and then taken off[18,32]. This was applied three times a week for 16 weeks.

The control group A received NDT only without inflatable pressure splint. Treatment was carried out for both groups A&B for 16 successive weeks, three days/week. Each session lasted about 90 minutes.

- NDT: this program was giving to all children in both groups. It consisted of facilitation of righting and equilibrium reactions, training of protective reactions, approximation technique, training of pelvic stability and equal weight shift on both sides, training of active trunk extension strengthening exercises, stretching exercises, balance training exercises[20].

Statistical Analysis

Data were collected and statistically analyzed using the arithmetic mean, standard deviation for all values. Paired t-test was used to compare means for stability index before and after treatment. Wilcoxon Matched- pairs signed-Ranks test was used for comparison between pre- and post treatment scores of the MAS. Level of significance was set at $p<0.05$.

RESULTS

The results of this study showed that there was statistically significant decrease in the stability index scores and MAS grades in group A, for group B there was statistically highly significant decrease in both SI scores and MAS grades in group B.

Balance data:

The mean values of the stability index for the control group (A) were 4.633± 1.029 before treatment and 3.74 ±1.051 after treatment which indicated a statistically significant difference with $P < 0.05$. On the other hand, the mean values of SI for the study group (B) before and after treatment were 4.827 ±1.081 and 2.771±0.6775 respectively. A highly significant difference was found as $P<0.001$ (table 1). Moreover as shown in figure 1 and table 2 there was no difference between the two groups before treatment ($p>0.05$). While a highly significant difference was found as $P<0.001$ after treatment in favour of the study group.

Table (1): Mean values of stability index of diplegic children for both groups (A&B) before and after treatment.

	Control group		Study group	
	Before	**After**	**Before**	**After**
Mean	4.633	3.740	4.827	2.771
SD	1.029	1.051	1.081	0.6775
P	< 0.05 *		< 0.001 **	

Values are mean ±SD 0.05 * Significant 0.001** Highly Significant

Table (2): Comparison of stability index between control and study group before and after treatment.

	Group A Control group	Group B Study group	t	P
Before treatment	4.633 ±1.029	4.827±1.081	.50154	.619914
After treatment	3.740±1.051	2.771±0.6775	2.6630	.001**

0.001** Highly Significant P >0.05 Non Significant

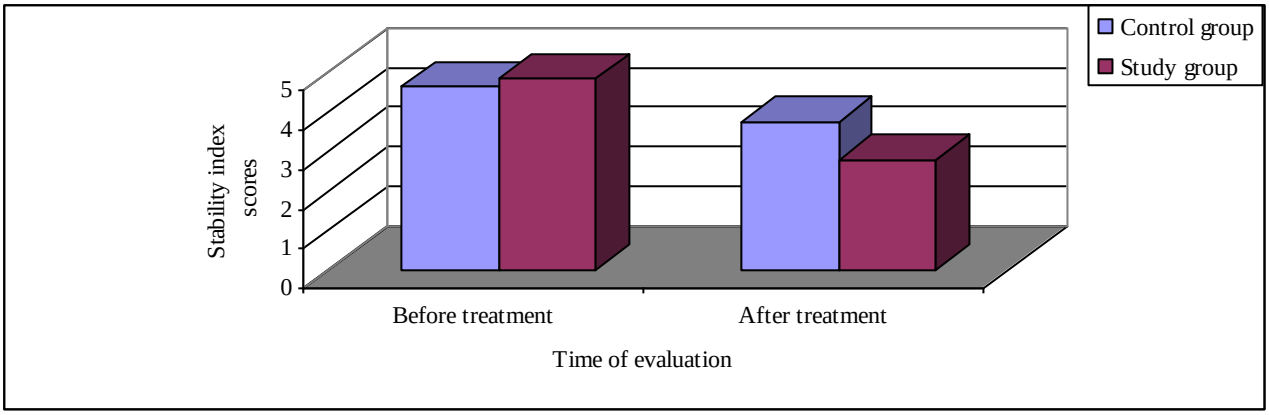

Fig. (1): Mean values of stability index scores for both the control and study groups before and after treatment.

Modified Ashworth Scale data:

The results represented a significant differences in MAS scores of planterflexors muscles for both sides for control group (A) before and after treatment with (P=0.0022) and (P=0.0014) respectively. Also, there was a significant difference in MAS scores of quadriceps muscles (Rt.& Lt. sides) before and after treatment for control group (P=0.0015) and (P=0.0015) respectively. Moreover, significant differences were found in MAS scores of planterflexors for both sides of study group (B) before and after treatment with (P<0.0014) and (P<0.0014) respectively. Also, there was a statistically significant difference in MAS scores of quadriceps muscles for both sides before and after treatment (P=0.009) and (P=0.0014) respectively for study group (B), as shown in table 2 and figure 2&3.

Table (3): Comparison of Modified Ashworth Scale for ankle planter flexors and quadriceps for both lower limbs before and after treatment for both control and study groups.

		Planterflexors		Quadriceps	
		Right side	**Left side**	**Right side**	**Left side**
Control group	**Z**	3.06	3.18	3.18	3.18
	P	0.0022	0.0014	0.0015	0.0015
Study group	**Z**	3.18	3.17	3.30	3.18
	P	0.0014	0.0014	0.009	0.0014

Wilcoxon p<0.05 significant

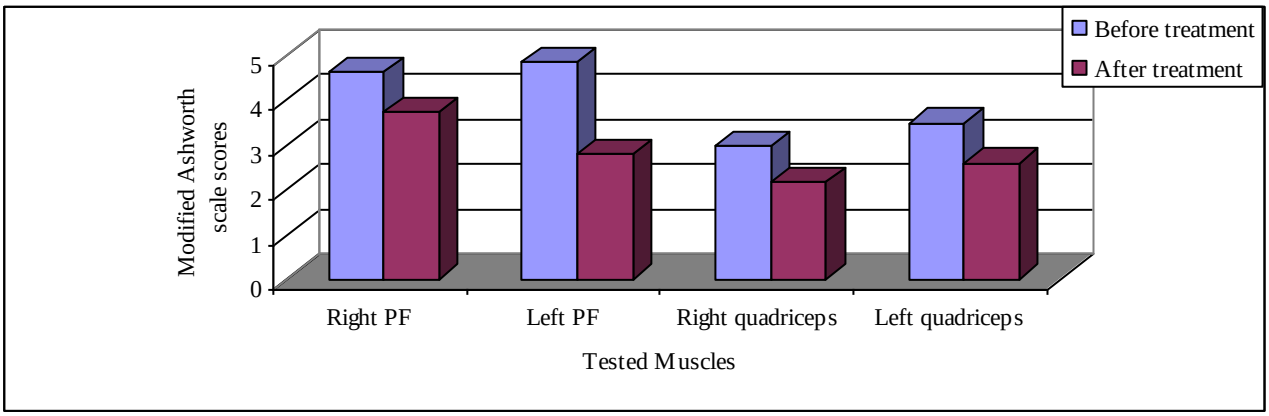

Fig. (2): Mean values of modified Ashworth scale for the control group.

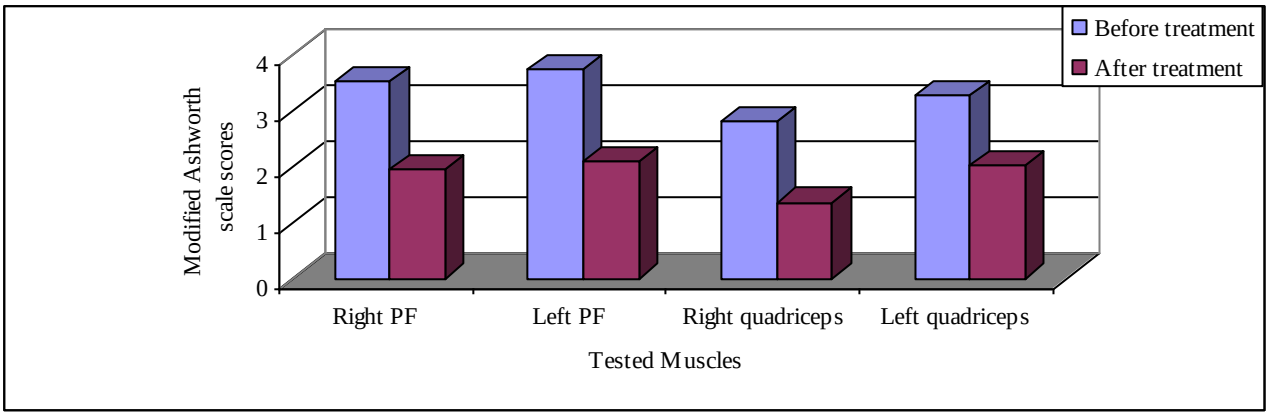

Fig. (3): Mean values of modified Ashworth scale for the study group.

As shown in table 4 there were no significant difference (P>.05) before treatment between both the study and control groups for the tested muscles (Rt. PF, Lt. PF, Rt. Quad. and Lt. Quad.).On the other hand a significant difference was found (P<. 05) after treatment between both groups for the latter muscles.

Table (4): Comparison of Modified Ashworth Scale for ankle planter flexors and quadriceps for both lower limbs before for both control and study groups and after treatment for both control and study groups.

Muscle tested		Control group (Mean±SD)	Study group (Mean±SD)	Z	P
Rt. PF	**Before**	3.73±. 4577	3.53± .5164	1.01	.3105
	After	2.60±. 5070	1.94± .5936	2.54	.0021*
Lt. PF	**Before**	3.68± .4684	3.74± .5047	1.25	.6213
	After	2.83± .4590	2.10± .6872	2.17	.0036*
Rt. Quadriceps	**Before**	2.98± .6821	2.79± .3912	1.84	.6941
	After	2.16± .5874	1.36± .2497	3.42	.0017*
Lt. Quadriceps	**Before**	3.48± .3821	3.26± .9823	1.52	.6731
	After	2.59± .5493	2.02± .6821	3.44	.0012*

Rt. Right, Lt. Left, PF planterflexors. Wilcoxon $p<0.05$ significant $P>0.05$ non significant

DISCUSSION

In this study, the stability index scores and spasticity grades were decreased significantly in both control and study groups (A&B). Moreover, the reduction was significantly higher in the study group (B). The data collected from this study indicated that, the combined use of inflatable pressure splint and NDT have played an important role in reducing spasticity and improving balance ability in spastic diplegic children.

It's well known that children with CP have difficulties with balance control. A number of neural factors have been hypothesized to contribute to these balance difficulties, including spasticity, or hyperactive stretch reflexes, increased co-activation of muscles at individual joints and muscle weakness. In addition, children are known to have musculoskeletal constraints including a crouched posture, that could also contribute to balance problems[40]. It has been shown that balance problems seen in CP children can be attributed to five major factors: (1)defective recruitment of motor units; (2)abnormal velocity-dependant recruitment during muscle stretch (spasticity); (3) nonselective activation of antagonistic muscles; (4) interference of immature or non pertinent motor program and (5) changes in passive mechanical properties of muscles[10]. The contribution of non-neural (mechanical) system to balance difficulties, as the crouch stance, in spastic diplegic CP children was suggested[8]. In studying standing balance it was noted that CP children show reversal of the normal distal to proximal muscle response pattern and excessive co-activation of antagonist muscle on response to support surface perturbations[27].

The results of this study agreed with Bertoti,1986[2] who found that muscle tone decreased and postural control and symmetry improved in the group of CP children who received inhibitory cast with NDT than the other group that were treated with NDT alone.

In 2003, study of Bache et al., showed that children with spastic diplegia exhibit spasticity and then contracture in muscle groups principally acting in the sagittal plane resulting in the characteristic crouch gait. These muscles include psoas, the hamstrings, the rectus femoris and the gastrocnemius. These are principally the two joint muscles. Muscles, which cross only one joint, are much less likely to develop contracture than those

that cross two joints[1]. Spasticity of these muscles adversely affects motor development by causing abnormal posture and movement pattern and delays the acquisition of ambulation skills including sitting, crawling, standing and walking. Therefore, the inhibition of spasticity is very important in treatment of children with CP[4].

Johnstone stated that inflatable pressure splints could be used to reduce spasticity, to inhibit the pathological reflexes and to increase stability at lower limbs in children with CP[15].

In this study, pressure was applied by inflatable pressure splint circumferentially around the lower limb combined with NDT in spastic diplegic CP. There was significant reduction of spasticity in both the planterflexors and quadriceps muscles after four months of treatment. These results could be explained as circumferential pressure compresses the limb with minimal muscle stretching. Therefore the reduction of spasticity was assumed to be attributed to an increase in presynaptic inhibition of Ia afferent by facilitation of cutaneous mechanoreceptors. Also circumferential pressure increases the discharge rate of muscle spindle afferents by slightly stretching the underlying muscle[33]. It may be argued that the amount of muscle stretch that occurs from circumferentially applied pressure is negligible and therefore did not affect stretch receptors. It was found that muscle spindle discharge in response to small length changes can postsynaptically inhibit alpha motorneuron24.

Johnstone postulated that impulses from cutaneous receptors directly influence motorneuron excitability in the spinal cord or indirectly by reticular formation. Natural heat and pressure applications decrease the excitability levels of stimuli. Therefore, they decrease the excitability levels of both interneurons and motorneurons[15]. The results of this work came in agreement with Kerem et al., 2001 who found that, pressure splints were effective in reducing spasticity in spastic diplegic CP children[18]. Similar results were found in adults as circumferential pressure reduced motorneuron reflex excitability in patients with spinal cord injury[33] as well as in normal subjects and in patients with stroke[32].

Physiotherapy and rehabilitation approaches are important components in treatment of CP. Various physiotherapy methods have been applied to obtain normal motor development, to prevent postural abnormalities and deformities and to increase functional capacity. Although rehabilitation of CP varies according to clinical types, the basic treatment is based on neurodevelopmental approaches. The aim of treatment is to improve corrective and balance reactions and to decrease excessive muscle tone and to improve postural tone by preventing abnormal muscle tone[35].

The beneficial effects of combined NDT and inflatable pressure splints could be explained by the effect of programmed repetition (used in NDT) as a mean of teaching the brain to improve motor performance skills and sensory input (inflatable pressure splints), linked to motor performance, which is a critical factor in bringing about the desired motor improvement[13].

The results were also coincident with those of Vermeer& Bakx, 1990 and Teplicky et al., 2002 who found that, lower limbs casting and orthoses in CP children had positive effects on balance and walking symmetry[38] and have shown short-term effect on improving ankle movement[37].

Regarding the intensity of physical therapy as mentioned in this study, Bower et al., 2001[6] compared the effects of the usual amount of physical therapy to intensive

therapy (one hour per day, five days per week) over a six month period in children age three to 12. They found no significant difference between the groups in either function or performance at the end of the six-month treatment period. The results of our study came in contrast to Watt's finding (1986)[39], who found that no significant differences between pre and post treatment muscle tone and motor development in children with CP after long term effects of a treatment consisting of NDT and inhibitory cast application.

Conclusion

According to the results of this study inflatable pressure splint as well as an additional physiotherapy procedure can be of help in inhibiting spasticity and abnormal motor pattern as well as improving balance in spastic diplegic children.

REFERENCES

1- Bache, C.E., Selber, P. and Graham, H.K.: The management of spastic diplegia. Current Orthopaedics, 17: 88-104, 2003.
2- Bertoti, D.B.: Effects of short casting ambulation in children with cerebral palsy. Physical Therapy, 66: 1522-1529.
3- Bleck, E.E.: The sence of balance. Dev Med Child Neurol.36: 377-378, 1994.
4- Bobath, K. and Bobath, B.: Motor development in the different types of cerebral palsy.London:the White Friars press,1981.
5- Bohannon, R. and Smith, M.: Interrater reliability of a modified Ashworth scale of muscle spasticity. Phys Ther. 67: 206-207, 1986.
6- Bower, E., Michell, D. and Camobell, M.: Randomized controlled trail of physiotherapy in 56 children with Cp followed for 18 months. Dev Med Child Neutolo, 43: 4-15, 2001.
7- Burns, R., Gilmour, J. and Kentish, M.: Physiotherapy management of children with neurological, neuromuscular and neuro-Developmental problems. In: Burns RY, Macdonald J, editors. Physiotherapy and growing child. London: WB Saunders. 1996.
8- Burtner, P., Qualls, C. and Woollacott, M.: Muscle activation characteristics of stance balance control in children with spastic cerebral palsy. Gait and posture, 8: 163-174, 1998.
9- Crenna, P. and Inverno, M.: Objective detection of pathophysiolocal factors contributing to gait disturbance in supraspinal lesions. In: Fedrizzi, E., Avanzini, G., Crenna, P., editors. Motor Development in children. London: John Libbey, 103-118, 1994.
10- Crenna, P.: Spasticity and spastic gait in children with cerebral palsy. Neurosci Biobehav Rev. 22: 571-578, 1998.
11- Girolami, G. and Camoell, S.: Efficacy of Neurodevelopmental treatment program to improve motor control in infants born prematurely. Paeditrics Physical Therapy, 6: 175-184, 1994.
12- Goldstein, E.M.: Spasticity management: an overview. J Chil Neurol, 16: 16-23, 2001.
13- Goldstein, M.: The treatment of cerebral palsy: What we know, what we do not know. J Pediatr, 145: S42-S46, 2004.
14- Haas, B., Bergstorm, E. and James, A.: The interrater reliability of original and modified Ashworth scale for assessment of spasticity in patients with spinal cord injury. Spinal cord, 34: 560-564, 1996.
15- Johnstone, M.: Restoration of motor function in stroke patient. New York: Churchill Livingstone, 1983.
16- Jones, K. and Barker, K.: Human movement explained, Butterwort-Heinemann, Oxford, 1996.
17- Katz, R.T. and Rymer, W.Z.: Static Hypertonia: mechanisms and measurement. Arch Phys Med Rehabil, 70: 144-155, 1989.
18- Kerem, M., Livanelioglu, A. and Topcu, M.: Effects of Johnstone pressure splints with Neurodevelopmental therapy on spasticity and cutaneous sensory inputs in spastic cerebral palsy. Dev Med Child, 43: 307-313, 2001.

19- Kluzik, J., Fetters, L. and Coryell, S.: Quantification of control: a preliminary study of Neurodevelopmental treatment on reaching in children with cerebral palsy. Physical therapy, 70: 65-78, 1990.
20- Knox, V. and Evans, A.L.: Evaluation of the functional effects of a course of Bobath in children with cerebral palsy: a preliminary study. Dev Med Child Neurol, 44: 447-460, 2002.
21- Lance, J.W.: Symposium Synopsis. In Feldman RG, Young RR, Koella WP,editors. Spasticity: Disordered motor control. Chicago: Year Book Medical Publishers, 485-494, 1980.
22- Lee, W.A., Deming, L. and Sahgal, V.: Quantitative and clinical measures of static standing balance in hemiparetic and normal subjects. Phy.Ther. 68(6): 970- 976, 1988.
23- Lephart, S.M., Pincivero, D. and Henry, T.: Learning effects and Reliability of the Biodex stability system. J.Athletic training; S30: S35, 1995.
24- Lunderberg, A., Malmdren, K. and Schomburg, E.: Reflex pathways from group II muscle afferents2: functional characteristics of reflex pathways to alpha motorneurons. Exp Brain Res, 65: 282-93, 1987.
25- Marin-Padilla, M.: Developmental neuropathology and impact of perinatal brain damage: II. White matter lesions of the neocortex. J Neuropathlo Exp Neurol, 56: 219-235, 1997.
26- Murray, M., Seieg, A. and Sepic, S.: Normal postural stability and steadiness: Quantitative assessment. J Bone Joint Surg. 57A: 510-516, 1975.
27- Nashner, L., Shumway-cook, A. and Marin, O.: Stance posture control selected groups of children with cerebral palsy: deficits in sensory organization and muscular coordination. Exp Brain Res. 49: 393-409, 1983.
28- O'Brien, C.F.: Treatment of spasticity with botulinum toxin. Clin J Pain, 18(Suppl): S182-190, 2002.
29- Park, T.S. and Owen, J.H.: Surgical management of spastic diplegia in cerebral palsy. N Engl J Med, 326: 745-749, 1992.
30- Petersen, M.C. and Whitaker, T.M.: Cerebral Palsy.In:wolraich, M.L.(ed.), Disorders of development and learning. 3rd ed., BC Decker Inc, Hamilton, London, 117-136, 2003.
31- Poole, J. and Whitney, S.: The effectiveness of inflatable pressure splints on motor function in stroke patients. Journal Research, 10: 360-366, 1990.
32- Robichaud, J., Agostinucci, J. and Vander Linden, D.: Effects of air splint application in soleus muscle motorneuron reflex excitability in nondisabled subjects and subjects with cerebrovascular accidents. Phys Ther., 72(3): 176-183, 1992.
33- Robichaud, J. and Agostinucci, J.: Air splint pressure effects on soleus muscle alpha motorneuron reflex excitability in subjects with spinal cord injury. Arch Phys Med Rehabil., 77: 778-782, 1996.
34- Rozzi, S.L., Lephart, S.M., Sterner, R. and Kuligowski, L.: Balance training for persons with functionally unstable ankles. JOSPT: 29: 478-486, 1999.
35- Semans, S.: A neurophysiological approach to treatment of cerebral palsy: Introduction to Babath method. In: Rothstein JM, editor. Cerebral palsy discussion and reviews. Vol 1. Alexandria, VA:American Physical Therapy Association. 191-197, 1995.
36- Shephered, R.: Maturation, pathophysiological and recovery processes in paediatrics.3rd edtition. Oxford: Butterworth, Heinemann press, 1999.
37- Teplicky, R., Law, M. and Russell, D.: The effectiveness of casts, orthoses and splints for children with neurological disorders. Infants Young Child, 15: 42-50, 2002.
38- Vermeer, A. and Bakx, V.: Evaluating intervention research with cerebral palsied children: a literature review. J Rehabil Sci. 3: 7-15, 1990.
39- Watt, J.: A prospective study of inhibitive casting as an adjunct to physiotherapy for cerebral palsied children. Developmental Medicine and Child Neurology, 28: 480-488, 1986.

40- Woollacott, M., Burtner, P. and Jensen, J.: Development of postural responses during standing in healthy children and children with spastic diplegia. Neurosci and Biobehav Rev. 22: 583-598, 1998.

الملخص العربى

تأثيرالجبيرة الهوائية الضاغطة مع العلاج المرتكز على النمو العصبي على التشنج العضلي والاتزان عند الاطفال المصابين بالشلل الرباعي التشنجى

تم اجراء هذا البحث على 30 طفلا من الاطفال المصابين بالشلل المخي الرباعي التشنجى من الجنسين ، تتراوح أعمارهم من 8 سنوات الى 13 سنة لمعرفة تأثير الجبيرة الهوائية الضاغطة مع العلاج المرتكز علي النمو العصبي على التشنج العضلي و الاتزان عند هؤلاء الاطفال . ثم قسمت العينة عشوائيا الى مجموعتين متساويتين (كل منها 15 طفلا) . تم علاج مجموعة الدراسة بواسطة الجبيرة الهوائية الضاغطة لمدة عشرين دقيقة فى الجلسة الواحدة بالاضافة الى تطبيق العلاج المرتكز علي النمو العصبى ، بينما تم علاج المجموعة الضابطة بأستخدام العلاج المرتكز علي النمو العصبى فقط . كانت مدة العلاج لكلا المجموعتين 16 اسبوعا بمعدل ثلاثة أيام أسبوعيا . تم تقييم جميع الاطفال المصابين مرتين ، مرة قبل بداية العلاج والمرة الثانية فى نهاية العلاج بأستخدام كلا من : جهاز البيودكس ، لقياس قدرة الطفل على الاتزان فى حالة الوقوف على الساقين فى جميع الاتجاهات على مستوى اتزان (8) و مقياس اشوارس المعدل ، لقياس درجة الشلل التشنجى فى كلا من عضلة الفخذ الرباعية و عضلة السمانة . وفى نهاية الدراسة تم مقارنة نتائج التقييمين احصائيا . و قد أظهرت نتائج الدراسة أن أستخدام الجبيرة الهوائية مع العلاج المرتكز علي النمو العصبى يفوق استخدام العلاج المرتكز علي النمو العصبى فقط بمدى كبيرو ذو دلالة احصائية عالية فى مجموعة الدراسة . وهذه النتائج تدل على أن أستخدام الجبيرة الهوائية الضاغطة مع العلاج المرتكز علي النمو العصبى ذات فائدة كبيرة فى تحسين الاتزان ودرجات التشنج العضلي عند هؤلاء الاطفال .