Influence of Hyperbaric Oxygen Therapy on Tone Modulation, Gross Manual Dexterity and Inspiratory Capacity of Spastic Hemiparetic Cerebral Palsied Children

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ABSTRACT

The purpose of this study was to investigate the effect of hyperbaric oxygen therapy on modulation of muscle tone, the gross manual dexterity and inspiratory capacity in spastic hemiparetic cerebral palsied children. Forty children with spastic Hemiparetic cerebral palsy ranged in age from 4 to 7 years participated in the study. The sample was divided into two equal groups (control and study groups). The control group was treated by a specially designed physical therapy program. The study group received hyperbaric oxygen therapy in addition to the same designed physical therapy program. Evaluation was carried out for each child in both groups before intervention and after three months of intervention. The H/M ratio was measured by the use of the EMG apparatus, the gross manual dexterity of the affected upper extremity was measured by the use of the Box and Block Test and the inspiratory capacity was measured by incentive spirometer. The results revealed significant reduction of spasticity and improvement of the gross manual dexterity of the affected upper extremity and the inspiratory capacity for both study and control groups after the treatment ($p<0.05$). However, when comparing the results of study and control groups, there were non-significant differences in both reduction of spasticity or improvement of the gross manual dexterity and the inspiratory capacity. These non-significant differences may be attributed to the low numbers of hyperbaric oxygen therapy sessions.
Key words: *Cerebral palsy, Hyperbaric oxygen therapy, H/M ratio, Gross manual dexterity, Inspiratory capacity, Physical therapy program.*

INTRODUCTION

Cerebral palsy (CP) is an umbrella term covering a group of non progressive, but often changing, motor impairment syndromes secondary to lesions or anomalies of the brain arising in early stages of its development[14].

Spastic CP is the most common motor impairment type, accounting for approximately 70-80% of all cases of CP. Approximately 25-35% of spastic CP children have spastic diplegia, 35-40% have spastic hemiplegia and 40-45% have spastic quadriplegia[21].

Patients with spastic hemiplegia have gross involvement of the limbs on one side. Their difficulties are often unnoticed in the first month of life. Hypotonia may be the first indication of hemiplegia in the newborn[27]. Children with spastic hemiplegia may experience hemiparetic tremors, uncontrollable shaking of the limbs on one side of the body. The arm is generally affected more than the leg. Learning disabilities, vision problems, seizures, and dysfunction of the muscles of the mouth and tongue are classic symptoms[24].

Manipulative movement refers to both gross and fine motor manipulation. Gross motor manipulation involves imparting force to, or receiving force from objects (e.g., throwing and catching). Fine motor manipulation involves intricate use of the muscles of the hand and wrist (e.g., typing and sewing)[7].

Children with hemiplegic CP exhibit a number of difficulties when reaching and grasping, including a general slowness in speed of the affected limb, delay in the initiation of reaching, slowness in flexing the fingers to grasp, overextension of the fingers, weak grasp and undulating change in grip power. There are also differences in the control of the fixating muscles of the wrist. As an object is grasped, wrist extensors normally fix the wrist to act with the fingers, providing efficiency and power. Children with CP often flex their wrist towards the object, which disrupts the fixation of the wrist[28].

Hyperbaric oxygen therapy (HBOT) refers to intermittent treatment of the entire body with 100% oxygen at greater than normal atmospheric pressures. The earth's atmosphere normally exerts 14.7 pounds per square inch of pressure at sea level. That pressure is defined as one atmosphere absolute (abbreviated as 1 ATA). In the ambient atmosphere, we normally breathe approximately 20% oxygen and 80% nitrogen. While undergoing HBOT, pressure is increased up to two times (2 ATA) in 100% oxygen[29]. In contrast to attempts to force oxygen into tissues by topical applications at levels only slightly higher than atmospheric pressure, HBOT involves the systemic delivery of oxygen at values 2-3 times greater than atmospheric pressure[11]. The HBOT is usually performed to alleviate hypoxia at the cellular level for a prescribed amount of time, usually 60 minutes for 5 days per week. It is common to administer 20 treatments sessions in the first phase of treatment[26].

With HBOT, 100% oxygen is breathed through a mask or clear hood when a patient reaches a depth that is appropriate for the condition being treated. The child with CP is treated at a depth of 1.5 ATA and not greater than 1.75 ATA or 16.5- 24 feet below sea level in either a monoplace chamber (holding one person) or a multiplace chamber (which can seat multiple people). The patient is accompanied by either a parent or caregiver if necessary and will sit on the bench seats next to other patients with the same condition and a chamber attendant. The chamber is pressurized and when the appropriate depth is reached the patients starts to breathe the 100% oxygen for 60 minutes. When the treatment is over, the mask or hood is slowly released, bringing everyone back to the atmospheric pressure of the outside of the chamber[12, 15].

Studies that have examined the improvements in patients' functional outcomes have been primarily anecdotal. Observations of improved neurological status, improve awareness, improves verbalization, increase speed of performance, prolonged standing, and improved level and change in level of ambulation have been noted[20].

The efficacy of HBOT as an important part of the treatment was demonstrated in certain acute disease processes as stroke, hypoxia, diabetic foot, carbon monoxide poisoning, some thermal burns, gas gangrene and cerebral palsy[17].

Hyperbaric oxygen therapy produces physiological changes, such as reduced intracranial pressures[22], an increase in the grey matter metabolic activity in CP children[20] and a reduced cerebrospinal fluid pressures[25]. It relieves the oxygen starvation of the brain known as hypoxia. Since full blood circulation to specific areas of the brain are impaired, increasing the rate at which oxygen diffuses into all of the body's fluids, increases the amount of oxygen carried to the hypoxic brain tissues. Oxygen enriched cerebrospinal fluid will help to repair any recoverable brain tissue that is intact but not functioning normal. In many cases, HBOT has shown these idling neurons have started to function more efficiently, producing long-term improvements in both brain and clinical function. With the improvement of microcirculation and the relief of any brain swelling, a patient can experience a reduction in spasticity and an improvement in cognitive ability, vision, hearing and speech[19]. Children with CP have experience some form of injury to their brain before, during or shortly after their birth. The availability of oxygen is essential to any healing process. The purpose of HBOT is to oxygenate the cells of the body to promote healing of damaged tissues, to decrease swelling and to improve circulation. In the case of cerebral palsy, there may be some recoverable (dormant, not dead) brain tissue around the damage areas that may be able (when activated by HBOT) to take over some of the functions of the damaged areas[5].

The purpose of this study was to investigate the impact of HBOT in addition to physical therapy program on tone modulation, the gross manual dexterity of the affected upper extremity as well as on inspiratory capacity in spastic hemiparetic cerebral palsied children. It was hypothesized that the HBOT would have no additional significant effect on tone modulation, the gross manual dexterity of the affected upper extremity as well as on inspiratory capacity when combining it with the physical therapy program applied for the spastic hemiparetic cerebral palsied children. The significant of the study was to seek for an additional treatment modality that could be used in conjunction with the traditional physical therapy program aiming to reduce spasticity, improve the gross manual dexterity as well as inspiratory capacity of the children with spastic hemiparetic CP.

SUBJECTS, MATERIALS AND PROCEDURES

Subjects

The total participants were 40 children with spastic hemiparetic CP. They were selected from the Pediatric Outpatient Clinic, Faculty of Physical Therapy, Cairo University with no previous history of HBOT. The children were randomly selected from both sexes (21 boys and 19 girls). Their ages were ranged from 4 to 7 years with mild to moderate spasticity according to the modified Ashworth scale (grades 1 and 1+). Exclusion criteria included any auditory or visual defects, heart or respiratory defects, contractures, IQ less than 60, previous rhizotomy, recent thoracic surgery, seizures, cancer, chronic asthma and/or ventriculo-perotineal shunts.

After parental permission, the children were randomly divided into two equal groups. The control group (7 right sided and 13 left sided) received a specific designed physical therapy program only[1], while the study group (9 right sided and 11 left sided) received HBOT in addition to the specific designed physical therapy program.

Materials

There were instrumentations for evaluation as well as for treatment. For evaluation, computerized electromyography (EMG) apparatus (Neuroscreen plus-version 1.59 produced by toennies, a division of Erich Jseger Gmbh, Germany, 1998) was used for H/M ratio study in which maximum H-reflex amplitude and minimum M-response amplitude were recorded from soleus muscle following tibial nerve stimulation at the popliteal fossa. Box and Block Test (BBT) was used to evaluate gross manual dexterity[30]. The EMG study was performed for the affected lower extremity while the BBT were performed for the affected upper extremity for both groups. A digital stop watch was used to calculate the time of the performance of the BBT. A modified Ashworth scale[4] was used to measure the degree of spasticity for all subjects before the beginning of the treatment. Incentive spirometer (Voldyne Volumetric manufactured by Sherwood Medical Company U.S.A.): It is a respiratory therapy device that provides visual feedback in term of volumetric success as a patient performs a deep breath. Incentive spirometer was used in measurement of inspiratory capacity (IC).

For treatment; mats, medical balls, wedges, rolls, chairs, balance board, standing frame were used in addition to the chamber of the HBOT (multiplace chamber) made by Enviromental Tectonics Corporation County Link Industrial Park South Hampton, PA 18966 USA. Serial no 101667. Date 8/97.

Procedures

The following evaluating measures were performed for both groups before the treatment and after 3 months of intervention (at the end of the study). (1) Muscle tone assessment using H/M ratio: After sitting up the child properly on the examination table and the different electrodes were adequately fitted as follows; the active electrode was placed along mid dorsal line of lower leg, 2 cm below point of separation of gastrocnemius muscles and secured by adhesive plaster. The positive electrode was placed distal to active electrode in straight line over the tendoachilis and secured by adhesive plaster. The earth electrode was placed between recording and stimulating electrodes and the stimulating electrode was placed over tibial nerve just medial to mid point of knee crease in popliteal fossa (active stimulating electrode is proximally located). Bifocal nerve stimulation was conducted using the EMG stimulator. The stimulating electrodes were adjusted at popliteal fossa searching for the position at which the nerve is most easily stimulated using the least voltage to produce a large H-reflex with minimal M-response. The maximal amplitude of H-reflex is often obtained with low intensity. (2) The gross manual dexterity of the affected upper extremity was assessed by the BBT[2].

Both the control and the study groups received the specific designed physical therapy program[1]. This program includes neurodevelopmental techniques, approximation for the upper and lower extremities of the affected side, training for postural mechanism, strengthening exercises for the back and abdominal muscles, stretching exercises for tendoachilis, hamstring, hip adductors, shoulder adductors and medial rotators, elbow flexors, wrist and fingers flexors as well as the forearm pronators of the affected side.

The study group received HBOT that was given under a medical supervision in the "Hyperbaric Oxygen Therapy Lab" in Nasser Institute Hospital. The children was placed into the HBOT multiplace chamber with their parents alongside them for comfort or caregiver if necessary and sit on the bench seats next to other children, and trained volunteers gradually increase the pressure inside which take 10-15 minutes. At the equivalent depth of 18 feet below sea level, the children putted on clear hoods or a mask through which pure oxygen is pumped to them. Once the pressure reaches 26 feet below sea level (1.7 ATA), it is stabilized and child starts to breathe the 100% oxygen. After 60 minutes, the treatment is over and the mask or hood was removed and the pressure was gradually reduced to normal again which take 10-15 minutes and the child leaves the chamber. The whole process takes an hour and a half. Visual observation from inside and outside was available through view ports or windows; communication was maintained to the chamber via an intercom link.

Each single treatment session of HBOT lasted about 1.5 hour. This included 60 minutes in the chamber in addition to preparation time (15 minutes) and observation time (15 minutes). The patients were treated by the HBOT once a day for 5 days per week for 3 months. The physical therapy treatment was conducted for 1 hour every session, 3 times per week for 3 months.

Evaluation for the H/M ratio, gross manual dexterity and inspiratory capacity were performed before treatment and after three months of intervention.

The collected data were statistically analyzed to show the means and standard deviations for the H/M ratio, the number of blocks and inspiratory capacity before intervention (pre-intervention) and after three months of treatment (post-intervention) for both control and study groups. Independent t-test was applied to compare the pre-intervention results between both groups as well as to compare the post-intervention results between both groups. Finally, paired t-test was performed to compare between the pre- and post-intervention results for H/M ratio, the number of blocks as well as for inspiratory capacity for each group.

RESULTS

The general characteristics of the participants are shown in Table (1). When comparing the pre-intervention mean values of the H/M ratio for the control group with that for the study group, the results revealed no significant difference. The results also revealed non-significant difference when comparing the post-intervention mean values of the H/M ratio for the control group with that for the study group (Table 2 and Fig. 1).

Data Analysis

Table (1): General characteristics of the participants.

Group Number	Age (Year)		Side of Lesion		Sex		Spasticity Grade	
	Mean	SD	Rt	Lt	Boy	Girl	1	1+
Control Group (20)	5.71	±1.09	7	13	8	12	14	6
Study Group (20)	5.53	±1.07	9	11	13	7	12	8

SD: Standard deviation. Rt: Right side. Lt: Left side.

Table (2): Mean values of the H/M Ratio for the control and study groups before intervention as well as after three months of intervention.

Intervention	Group	Mean	SD	Minimum	Maximum	t-value	Sig.
Pre	Control Study	10.02 10.06	±6.74 ±6.41	0.6 1.6	23.6 19.3	0.98	NS
NS	0.59	20.3 18.1	0.4 0.4	±5.98 ±6.28	8.95 7.9	Control Study	Post

SD: Standard deviation. Sig.: Significance. t: Independent t-test. NS: Non-significant.

On the other hand, the results showed a significant difference between the pre- and post-intervention H/M ratio for the control group as well as for the study group (P<0.05) (Table 3 and Figure 1).

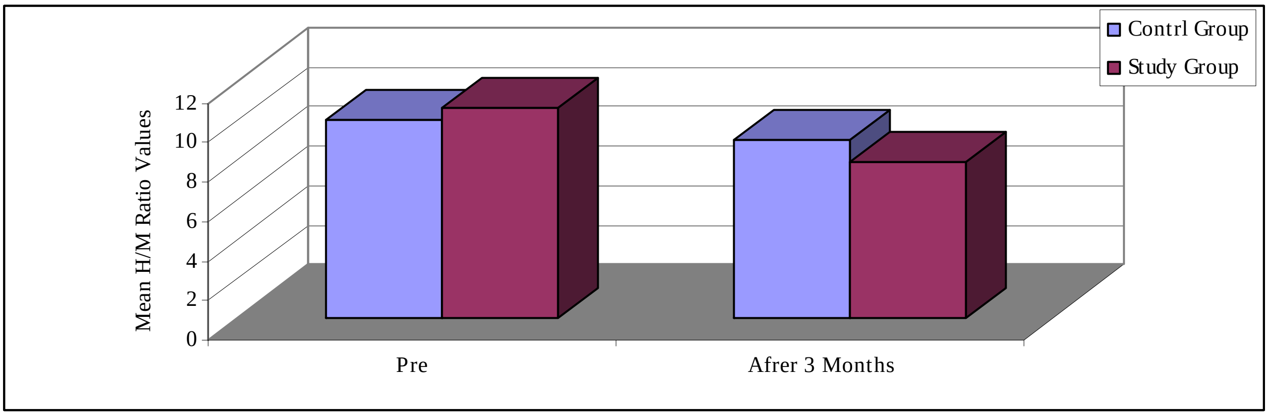

Fig. (1): Mean values of the H/M ratio for both groups before intervention and after three months of intervention.

Table (3): Mean values of the H/M Ratio before intervention and after three months of intervention for the control group as well as for the study group.

Sig.	t-Value	Maximum	Minimum	SD	Mean	Intervention	Group
S	3.72	23.6	0.6	±6.74	10.02	Pre	Control
		20.3	0.4	±5.98	8.95	Post	
S	3.16	19.3	1.6	±6.41	10.06	Pre	Study
		18.1	0.4	±6.28	7.9	Post	

SD: Standard deviation. Sig.: Significance. t: Paired t-test. S: Significant.

When comparing the pre-intervention mean values of the number of blocks for the control group with that for the study group, the results revealed no significant difference. The results also revealed non-significant difference when comparing the post-intervention mean values of the number of blocks for the control group with that for the study group (Table 4 and Figure 2).

On the other hand, the results showed a significant difference between the pre- and post-intervention mean values of the number of blocks for the control group as well as for the study group (P<0.05) (Table 5 and Figure 2).

Table (4): Mean values of the number of blocks for the control and study groups before intervention as well as after three months of intervention.

Sig.	t-Value	Maximum	Minimum	SD	Mean	Group	Intervention
NS	0.88	21	12	±2.41	17	Control	Pre
		21	12	±2.63	16.90	Study	
NS	0.66	40	29	±4.09	34.25	Control	Post
		42	28	±4.90	34.75	Study	

SD: Standard deviation. Sig.: Significance. t: Independent t-test. NS: Non-significant.

Table (5): Mean values of the number of blocks before intervention and after three months of intervention for the control group as well as for the study group.

Sig.	t-value	Maximum	Minimum	SD	Mean		Group
S	3.40	21	12	±2.41	17	Pre	Control
		40	29	±4.09	34.25	Post	
S	3.47	21	12	±2.63	16.90	Pre	Study
		42	28	±4.90	34.75	Post	

SD: Standard deviation. Sig.: Significance. t: Paired t-test. S: Significant.

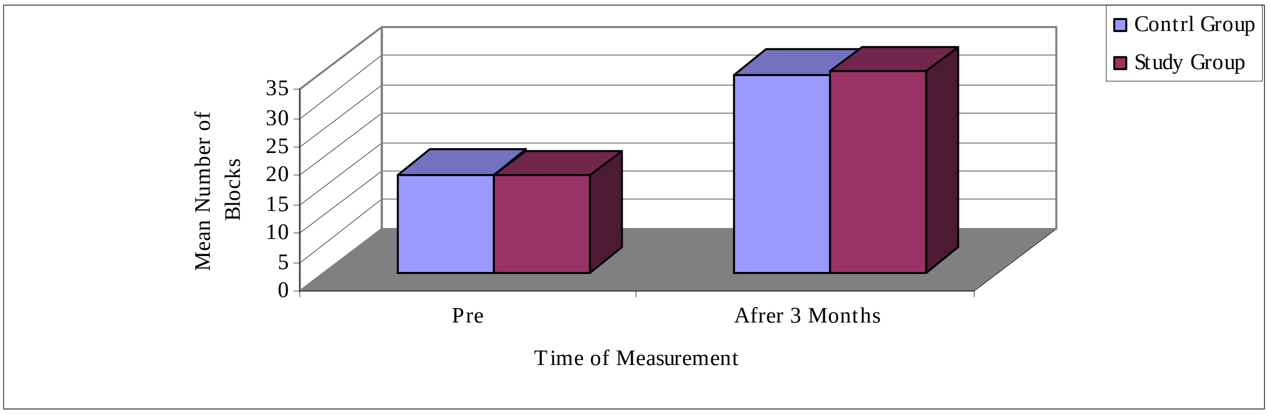

Fig. (2): Mean values of the number of blocks for both groups before intervention and after three months of intervention.

When comparing the pre-intervention mean values of the inspiratory capacity (I.C.) for the control group with that for the study group, the results revealed no significant difference. The results also revealed non-significant difference when comparing the post-intervention mean values of the inspiratory capacity for the control group with that for the study group (Table 6 and Figure 3).

Table (6): Mean values of the pulmonary function test included inspiratory capacity (I.C.) for the control and study groups before intervention as well as after three months of intervention.

Sig.	t-value	Maximum	Minimum	SD	Mean	Group	Intervention
NS	0.98	400	340	±23.63	360.10	Control	Pre
		420	350	±24.45	370.82	Study	
NS	1.62	450	400	±20.51	430.08	Control	Post
		460	410	±22.78	445.81	Study	

SD: Standard deviation. Sig.: Significance. t: Independent t-test. NS: Non-significant.

On the other hand, the results showed a significant difference between the pre- and post-intervention inspiratory capacity for the control group as well as for the study group ($P < 0.05$) (Table 7 and Figure 3).

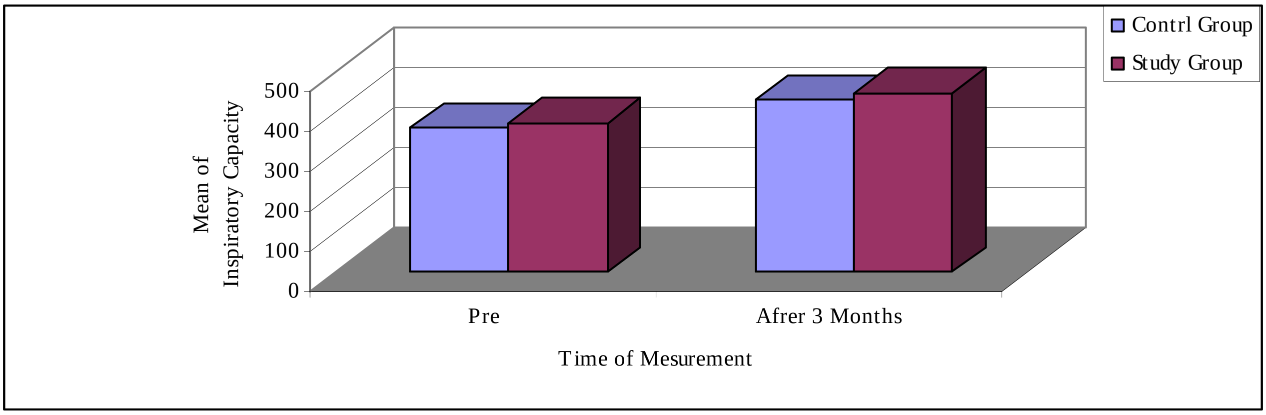

Fig. (3): Mean values of the inspiratory capacity for both groups before intervention and after three months of intervention.

Table (7): Mean values of the inspiratory capacity (I.C.) before intervention and after three months of intervention for the control group as well as for the study group.

Sig.	t-Value	Maximum	Minimum	SD	Mean	Intervention	Group
S	3.58	400	340	±23.63	360.10	Pre	Control
		450	400	±20.51	430.08	Post	
S	3.81	420	350	±24.45	370.82	Pre	Study
		460	410	±22.78	445.81	Post	

SD: Standard deviation. Sig.: Significance. t: Paired t-test. S: Significant.

DISCUSSION

There is insufficient information in the literature review regarding the usefulness of the HBOT in the treatment of CP. Little knowledge is available concerning the role of the HBOT on spasticity and gross manual dexterity in children with spastic hemiparetic CP. Most of the researches regarding the role of the HBOT concentrated on spasticity modulation and its effect of the improving of gross motor development, while few of these researches studied the effect of the HBOT on the gross manual dexterity of the children with spastic CP. Therefore, the purpose of this study was to investigate the efficiency of the HBOT on muscle tone modulation and the reflection of this modulation (if present) on the gross manual dexterity of the affected upper extremity and inspiratory capacity in children with spastic hemiparetic CP.

James (1988)[13] studied the effect of the HBOT on children with CP aging from 2 months to 10 years and reported 7% death rate. About 6% of the death rate occurred in children who were less than 2 years. Therefore, in this study the age range was from 4 to 7 years to eliminate any risk factor for death. In addition at this age range, the children are capable of cooperation and active participation.

Because physical therapy is concerned with restoration of function, quantifying functional progress by assessing clinical changes in motor function in children with CP is important though it is a complex task and concerned with muscle tone that is considered as the main cause of developmental delay. Therefore, the accurate detection of reduction of spasticity and change in function is the essential purpose of an evaluative outcome measure[23].

In the present study, we investigated the effect of the HBOT by evaluating the H/M ratio in the affected lower extremity as well as the performance of the affected upper extremity in the BBT in spastic hemiparetic cerebral palsied children.

For the study group, the results revealed a significant difference in both the H/M ratio and the number of blocks in BBT between the pre-intervention and after three months of intervention. These findings may be attributed to the combining effect of the HBOT and the physical therapy program. These results come in agreement with Neubauer and Edgar (1980)[18] who reported that the combination of hyperbaric medicine together with physical therapy produces improved overall results, we offer and highly recommend physical therapy as part of the overall management approach. Machado (1989)[16] stated that in follow up after three months after cessation of HBOT was noticed that 62 patients had persisting reduction of spasticity and improved motor control. In addition, the parents reported other improvement such as a better balance, the child being more attentive and more intelligent with reduced frequency of convulsions and episodes of bronchitis. Venter et al. (1998)[31] stated that HBOT achieves the best results when coupled with appropriate physical therapy, as HBOT leads to increase in attention that is particularly important for children to be aware of their environment in order to learn, which increase the effect of physical therapy training program. Our result regarding the improvement in spasticity and gross manual dexterity after three months of intervention come in agreement with Barretti et al. (2001)[3] and Heuser and Uszler (2001)[10] who found that HBOT caused improvements in tests of gross motor and fine motor function and decreased spasticity as measured by the modified Ashworth spasticity score in patients with CP. Collet et al. (2001)[8] also stated that HBOT show significant improvements in scores of GMFM when testing after three months of treatment.

The results of the study group could be explained by the finding of Neubauer and James (1998)[19] who reported that HBOT relieves the oxygen starvation of the brain known as hypoxia. Since full blood circulation to specific areas of the brain are impaired, increasing the rate at which oxygen diffuses into all of the body's fluids, increases the amount of oxygen carried to the hypoxic brain tissues. Oxygen enriched cerebrospinal fluid will help to repair any recoverable brain tissue that is intact but not functioning normal and increase the ability of these cells to produce reduction of spasticity and improvement of gross motor skills after physical therapy. Jain (1999)[12] reported that the mechanism of injury in CP subjects involves a gradient of hypoxia producing a range of cellular effects, from inactivity to cell death. As with any injury, persistent ischemia or hypoxia often results in progressive tissue loss. Early correction of hypoxia limits this effect and for brain tissue, provides the stimulus necessary for activation of suppressed neuron and increase ability to receive information from physical and occupational therapy. Hardy et al. (2002)[9] stated that some of brain tissues may be permanently damaged and the area surrounding may be in dormant state because the amount of oxygen it received has been reduced due to decrease in blood flow. The dormant area is referred to as "not dead but sleeping" so the cells in dormant area may remain in suspended animation for many years after an injury so it is believed that the high oxygen levels in HBOT cause physiological change to the cells of dormant area by waking them up thus increasing the capacity for recovery.

The results also showed non-significant difference regarding both H/M ratio and the number of blocks after three months of intervention between the control and the study groups. This may be attributed to the short time of treatment and only very dramatic changes would be detected. There was a clinical improvement in measuring variables in the study group than in control group, which reflected the more desirable effect of combined physical therapy program in addition to hyperbaric oxygen therapy on reduction of spasticity and improvement of gross manual dexterity in spastic hemiparetic cerebral palsied children.

The results of this study showed significant difference for both H/M ratio and the number of blocks after three months of intervention for the control group. This may be attributed to the introduced physical therapy program. This program was directed toward inhibiting the abnormal muscle tone and abnormal postural reflexes, facilitating normal patterns of postural control, weight bearing activities, facilitation of trunk control, and training for integral component of postural mechanisms developing a greater variety of normal movement patterns particularly in the trunk and lower extremities.

These last findings are supported by Claire et al. (1985)[6] who reported that neurodevelopmental techniques activities used in the treatment of child with spastic CP would increase antispastic muscle activity. Wilsdon (1996)[32] stated that physical therapy program helping neurophysiologic development and sensory integration. Ketellar et al. (2001)[14] reported that therapeutic approaches emphasis on two basic principles, normalization of the quality of movement and functional activities.

The findings of our study agree with that of Abd El-Ghafar et al. (2005)[1] who found that after three months of treatment, there was non-significant difference of the H/M ratio between two studied spastic CP groups. One of these groups received only physical therapy program and the other group received the physical therapy program in addition to the HBOT. The authors attributed their results to the small sample size (only 10 patients in each group), different CP diagnosis (4 quadriplegia, 4 diaplegia and 2 hemiplegia in each group) and to the short time of the study.

The results of this study showed significant difference for inspiratory capacity after three months of intervention for the study group (received hyperbaric oxygen therapy in addition to the designed physical therapy program) and the control group (received only the designed physical therapy program). This may be due inhibition of the abnormal muscle tone and abnormal postural reflexes, facilitation of normal patterns of postural and trunk control, and developing a greater variety of normal movement patterns particularly in the trunk and lower extremities in both groups as spasticity causes restriction in chest expansion and as a result all the lung volumes and capacities become decreased.

However, in our study, all the subjects were spastic hemiparetic CP children, the sample size was duplicated in each group but we apply the study for the same duration (three months). As our results also revealed non-significant differences between the study and the control group for both the H/M ratio, the number of blocks and inspiratory capacity after three months of intervention, this may be attributed to the short time of application. Therefore, further research is advised to determine the appropriate time required to achieve the benefits of the HBOT.

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الملخص العربي

تأثير العلاج بالأكسجين تحت الضغط على الأطفال المصابين بالشلل المخى النصفي التشنجي

يهدف هذا البحث إلى تقييم تأثير العلاج بالأكسجين تحت الضغط على النغمة العضلية في الطرف السفلى والبراعة اليدوية في الطرف العلوي المصاب و السعة التنفسية لدى الأطفال المصابين بالشلل المخي النصفي التشنجي. تم إجراء هذا البحث على أربعين طفل من المصابين بالشلل المخى النصفي التشنجي ممن تتراوح أعمارهم من 4 إلى 7 سنوات. تم تقسيم المرضى إلى مجموعتين متساويتين في العدد. تلقت المجموعة الأولى برنامجا خاصا من التمرينات العلاجية المختارة. و كذلك تلقت المجموعة الثانية نفس البرنامج الخاص من التمرينات العلاجية المختارة بالإضافة إلى جلسات العلاج بالأكسجين تحت الضغط. تم تقييم النغمة العضلية باستخدام جهاز رسم العضلات لقياس النسبة بين رد فعل هوفمان وقوه استجابة الأعصاب الحركية ، كما تم استخدام اختبار الصندوق والمكعبات لقياس البراعة اليدوية في الطرف العلوي المصاب بالاضافة لقياس السعة التنفسية باستخدام جهاز الحافز التنفسى . أجريت هذه القياسات قبل العلاج وبعد ثلاثة اشهر من العلاج للمجموعتين. وقد أوضحت الدراسة وجود فروق ذات دلالة إحصائية عند مقارنة نتائج ما قبل العلاج بنتائج ما بعد العلاج بالنسبة إلى قياس النسبة بين رد فعل هوفمان وقوه استجابة الأعصاب الحركية وكذالك بالنسبة إلى السعة التنفسية والبراعة اليدوية في الطرف العلوي المصاب في المجموعة الأولى والثانية كل على حدا. بينما أظهرت النتائج عدم وجود فروق ذات دلالة إحصائية عند مقارنة نتائج ما بعد العلاج بثلاثة اشهر بين المجموعتين وان كان هناك تحسن ملحوظ في المجموعة الثانية عن الأولى. وفقا لهذه النتائج نوصى بإجراء دراسات أخري مطولة لتقيم آثار العلاج بالأكسجين تحت الضغط على الأطفال المصابين بالشلل المخى .

الكلمات الدالة: *الشلل المخى التشنجي- العلاج بالأكسجين تحت الضغط- النسبة بين رد فعل هوفمان وقوه استجابة الأعصاب الحركية- البراعة اليدوية –السعة التنفسية- برنامج العلاج الطبيعي .*