

THE EFFECT OF HYBERPARIC OXYGEN THERAPY ON GROSS MOTOR SKILLS, SOCIALTY AND AWARNESS OF CHILDREN WITH CEREBRAL PALSYAND MENTAL HANDICAP

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Abstract

The current study examined the effects of hyperbaric oxygen therapy on gross motor skills, sociality and awareness of 12 children diagnosed as cases of cerebral palsy with mental handicap. A Questionnaire was filled by the parents and care providers who take care of those cases. The protocol of HBOT was 40 sessions of treatment of 100% oxygen at 1.75 atmospheres(atm) abs for 60 minutes. The averages and standard deviations were calculated to estimate the behaviors of the children before and after being subjected to the oxygen treatment program. Apparently, the results were encouraging, but after they were analysed, no statistical significant value was found. So the benefits of HBOT in such cases is controversial and lots of studies should be done.

Keywords: Hyperbaric oxygen therapy (HBOT), children with cerebral palsy

1. Introduction:

There is growing interest in the use of hyperbaric oxygen therapy (HBOT) for children with cerebral palsy and mental handicap (CP with MH). Although there is no rigorous evidence to support this management. HBOT for CP with MH children, however, is not new, few studies of its effectiveness have been completed and the research which documenting the effects of HBOT in such cases has been anecdotal. The importance of the study stems from the fact that it adds new evidence, and it is a prospective study. The families of the cases were involved,

and the study concentrated on the behavior related to the ability to learning, social interaction and nonadaptive behaviors. Although HBOT is being used with children with disabilities including cerebral palsy and autism, the results of this study proves that it is not significant in the cases studied. So the issue is still controversial.

1.1 Hyperbaric Oxygen Therapy

Hyperbaric Oxygen Therapy: It is a type of treatment using a special chamber, sometimes called a pressure chamber, to allow a person to get high levels of oxygen in the blood. This means that the air inside the pressurized chamber is typically greater than the normal atmospheric pressure. This makes the blood carry larger amounts of oxygen, and it brings this oxygen to the organs and tissues in the body through body fluids (Richard and Console, 2010).

1.2 Uses: The following uses have depended on strong evidence

- Certain non-healing wounds (post-surgical or diabetic)
- Radiation soft tissue necrosis and radiation osteonecrosis
- Necrotizing fasciitis (flesh eating bacteria)
- Carbon monoxide poisoning
- Decompression sickness
- Air or gas embolism
- Acute arterial ischemia (crush injury, compartment syndrome, etc)
- Severe infection by anaerobic bacteria (such as gas gangrene)
- Severe uncorrected anemia when blood transfusion is not available (e.g., in a Jehovah's Witness)
- Chronic refractory Osteomyelitis
- Diabetic foot (Patrick *et al*, 1996).

1.3 Mechanism and Effects

- Hyper-oxygenation increases oxygen carrying capacity
- Increased oxygen diffusion in tissue fluid
- Diffusion distance is proportional to the square root of dissolved oxygen
- Severe blood loss/anemia (unable to carry oxygen)
- Crush injury, compartment syndrome graft, and flap salvage (decreased perfusion)

- Edema (increased diffusion barrier)
- Decrease gas bubble size
- Boyle law - Gas volume is inversely proportional to pressure
- Hyperbaric diffusion gradient favors gas leaving the bubble and oxygen moving in, metabolizing oxygen in the bubble
- Decompression sickness
- Air embolus syndrome(Jepson *et al*, 2011)

1. 4 Secondary Effects

- Vasoconstriction, Decreased inflow into tissues,Decreased edema,
- Increased oxygen gradient between wound and surrounding environment,
- Increased fibroblast proliferation leading to increased collagen deposition and increased fibronectin, which aids in neovascularization (Catto *et al*,2011).
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1.5 Contraindications:

People with some diseases should not go under HBOT. Examples of such diseases are:claustrophobia, pneumothorax, history of spontaneous pneumothorax,chronic obstructive,pulmonary disease, seizure disorders,upper respiratory infection, hyperthermia, malignant tumors, acidosis, anxiety, gas embolitenion, increased lung bleb, increased risk seizures, increased barotraumas(Catto *et al*,2011).

1.6 Adverse Effect:

When used according to standard protocols, with oxygen pressures not exceeding atmospheres and treatment sessions limited to a maximum of 120 minutes, hyperbaric therapy is safe. However, some adverse effects may occur. Reversible myopia, which is a consequence of the direct toxic effect of oxygen on the lens, is the most common side effect. Cataract formation, however, has not been seen in patients treated according to standard protocols. A few patients may experience mild-to-severe pain from rupture of the middle ear, the cranial sinuses, and, in rare cases, the teeth or lungs as a result of rapid pressure changes - that is, barotrauma. Inhalation of high concentrations of oxygen under pressure may precipitate generalized seizures, but these are rare and self-limited, and cause no permanent damage.

With repeated exposure to hyperbaric oxygen, some patients have reversible tracheobronchial symptoms - chest tightness, a substernal burning sensation, and cough -with

concomitant reversible decrements in pulmonary function. Critically ill patients who have required high concentrations of normobaric oxygen for a prolonged period and then undergone repeated exposure to hyperbaric oxygen are at greater risk for toxic pulmonary effects. Claustrophobia can be a problem in monoplace chambers. No evidence of a tumorigenic effect of hyperbaric oxygen has been found to date (Patrick *et al*, 1996; Catto *et al*, 2011).

1.7 Cerebral Palsy and Mental handicap:

Mental handicap refers to below average intellectual ability; these children are often impaired in their ability to understand, communicate, solve problems, and function in social settings. Cerebral palsy refers to a disorder with impaired movement, causing problems with standing or walking, weakness, coordination, and muscle spasms. Children with cerebral palsy may have normal or below average intelligence. Mental handicap and cerebral palsy can also be associated with vision, hearing, and speech problems and possibly some physical deformity or emotional disturbance. Management of children with mental handicap or cerebral palsy requires the combined effort of doctors, therapists, and parents (Devinsky, 2008).

Cerebral Palsy:

Cerebral palsy is not a specific diagnosis, but an “umbrella term” describing the clinical presentation of non-progressive motor deficits in children during the first year of life, which can arise from a broad spectrum of etiologies. The inciting event occurs during the prenatal, natal, or postnatal period, when the developing brain and motor control system are immature and susceptible to various forms of injury. The world incidence of CP is 2.5/1,000 live births, and has a strong correlation with the degree of prematurity at delivery. Despite reductions in the rate of birth asphyxia over the past 20 years, the prevalence of CP has actually increased from 1.9 to 2.3/1,000 live births. The most likely explanation for this trend is improvement in survival of very low birth weight premature infants. With current practice, 85% of babies born weighing less than 1,500 grams survive, and up to 15% of these survivors are likely to exhibit significant spastic motor deficits.

Children with CP have developmental delay and static (i.e., non-progressive) motor deficits. The motor deficits are variable and they can include weakness, incoordination, spasticity, clonus, rigidity, and muscle spasms. Spasticity can be quite debilitating and, if left untreated, can lead to muscle fibrosis, musculoskeletal deformities and contractures. In addition, abnormal movements may be noted in some patients, including athetosis, chorea, and dystonia.

The motor deficits are often classified according to their severity (i.e., mild, moderate, severe) and topographical distribution (e.g., monoplegia, diplegia, triplegia, and quadriplegia) (Jan, 2006).

Many children with CP have normal intelligence, especially those with spastic diplegia. However, there is a strong correlation between the severity of CP and the presence of mental handicap. Other clinical features that can be associated with CP include epilepsy, bowel and bladder dysfunction, hearing loss, visual impairment, and poor nutritional status due to pseudo bulbar palsy. Overall, approximately 36% of CP patients develop epilepsy, with onset during the first year of life in over two thirds of the cohort (Zafeiriou, *et al*, 1999).

About 30% of all children with cerebral palsy have epilepsy. A much smaller proportion of those with epilepsy have cerebral palsy. Epilepsy and cerebral palsy are separate disorders, but both can result from the same abnormality of the brain. The two conditions can co-exist, but one does not cause the other. Mental handicap occurs in approximately one third of children with cerebral palsy.

Conventional treatment options will include physical and occupational therapy, drug therapy for spasticity, orthopedic procedures (e.g., orthotic devices, tendon lengthening), and neurosurgical intervention in selected cases (e.g., dorsal rhizotomy, peripheral neurotomy), (Bennett and Newton, 2007).

Mental Retardation:

The definition of the American Association on Mental Deficiency is the most relevant of the presently used psychological definitions to the educators or teachers, say that, mental handicap refers to significantly sub-average general intellectual functioning existing concurrently with deficient, in adaptive behavior, and manifested during the development period.

Classification of mental handicap: because there are many degrees and types of mental handicap and different kinds of specialists concerned with mental handicap, various classifications are used to describe mentally handicapped children, psychological classification, social classification, medical classification and educational classification which includes: slow learner, educable mentally handicapped, trainable mentally handicapped, and totally dependent or profoundly handicapped (Hallahan and Kauffman, 1994).

Causes of mental handicap: factors of mental handicap are classified into four main groups.

- Prenatal factor which occur during the pregnancy period (between fertilization and birth) and include:

- Genetic factors which include dominant, genes, recessive genes, single gene, chromosomal factors metabolic disorders, RH factors.
- Non genetic factors which include all the environmental factors that affects embryo and fetus before birth, as X Ray, German measles, syphilis, chemical drugs and alcohol, smoking, air and water pollution, malnutrition.
- Perinatal factors include, asphyxia, physical trauma, prematurity, dry birth.
- Postnatal factors include malnutrition, physical trauma, infections, chemical factors, deprivation factors.
- Unknown factors (Hallahan and Kauffman, 1994).

1.8 Cerebral Palsy and Oxygen Therapy:

How does HBOT Work?

Hyperbaric oxygen therapy is a treatment that exposes the body to 100% oxygen at greater than normal atmospheric pressure. The child is placed in a chamber that increases the amount of oxygen in the blood, which may allow extra oxygen to be filtered throughout the body and reach damaged areas. Medical professionals who use HBOT advocate the treatment as non-traumatic, non-invasive, and safe.

To understand why HBOT may be effective for children with cerebral palsy and other types of brain injury, one must understand what happens when brain damage occurs. When a brain injury happens, certain nerve cells are irrevocably damaged from either trauma or lack of oxygen. Blood plasma leaks into surrounding brain tissue, causing reduced blood flow and swelling. This lack of oxygen causes healthy cells in the surrounding areas to become dormant. Medical professionals who use HBOT believe that the high levels of pressurized oxygen introduced during HBOT increase blood flow, reduce swelling, and give the “sleeping” cells surrounding permanently injured cells in the brain a “wake-up call.” When these cells are revived, optimal recovery - even growth of new brain tissue - can occur. The result may be gains in cognitive and social functioning, as well as improved motor functioning (Richard and Console, 2010).

1.9 Evidence about HBOT in Cerebral Palsy

HBOT is controversial and health policy regarding its uses is politically charged. Both sides of the controversy on the effectiveness of HBOT are available. As Bennett and Newton (2007) stated, this is a considerable challenge for any research group, particularly for

clinical hyperbaric facilities, and cannot be mounted in the absence of support from the pediatric neurology community. The onus is on enthusiasts who are already convinced of the efficacy of HBOT for CP to encourage and prosecute these trials if they wish to persuade the skeptical. The skeptical in turn should be willing to assist in the interests of rational and cost-effective use of scarce resources, but can not be expected to drive an agenda for which they have little expectation of success.

Does HBOT treatment improve the function in CP?

There is insufficient evidence to determine whether the use of HBOT improves functional outcomes in children with cerebral palsy. The results of the only truly randomized trial were difficult to interpret because of the use of pressurized room air in the control group. As both groups improved, the benefit of pressurized air of HBOT at 1.3 to 1.5 atm should both be examined in future studies (Essex, 2003). A systematic review of HBOT in cerebral palsy identified only two randomized controlled trials (RCTs) and four observational studies with sufficient scientific rigor to merit inclusion in the review.

The best evidence was derived from an RCT conducted in the Canadian province of Quebec that compared two groups of children (n 5 111 overall) with cerebral palsy. One group received HBOT at 1.7 atm, and the other group received room air pressurized to 1.3 atm. Both groups received 40 sessions of treatment for 2 months. Blinded outcome assessors did not detect any statistical or clinically meaningful difference between the two groups in either the primary outcome measure or secondary outcome measure of the gross motor function assessed in this trial. An improvement in the gross motor function measure of roughly 5–6% over baseline was noted in both groups six months subsequent to treatment initiation, which strongly suggests that HBOT is not more effective than pressurized room air. This improvement has been attributed to the participation (i.e., Hawthorne) effect (Collet *et al.*, 2001).

The second RCT identified by the systematic review was judged to be of poor quality, and hampered by small subject numbers (n 5 26), a lack of blinded outcome assessment, vague subject ascertainment, a lack of important details regarding randomization and baseline comparability, and the absence of a true control group which did not undergo the HBOT intervention. Interestingly, this small RCT has never been published in the peer review literature and is available on a website alone (Packard, 2000).

Similarly, the four observational studies identified by the systematic review were all felt to be of poor quality, limited by retrospective design, lacking blinded outcome assessment, vulnerable to potential selection biases and confounder effects, and used no actual control

groups for direct comparison (Machado, 1989; Montgomery *et al.*, 1999; Chavdarov, 2002; and Waalkes, 2002).

At present, as stated by the 2007 systematic review, “the evidence is inadequate for establishing a significant benefit for HBOT” in the setting of cerebral palsy. While the trials and observational studies identified by the review did indicate an increase in the occurrence of either seizures or inner ear problems in children undergoing HBOT, accurate estimates of the prevalence of these adverse events was deemed uncertain (McDonagh *et al.*, 2007).

In 2003, the Agency for Healthcare Research and Quality (U.S. Department of Health and Human Services) reviewed the evidence of HBOT in cerebral palsy and concluded that there was ‘insufficient evidence to determine whether the use of HBOT improves functional outcomes in children with cerebral palsy.’ Thus, it appears that HBOT for cerebral palsy has moderate risks without an expected demonstrable benefit (Bell *et al.*, 2011).

The majority of evidence for the effectiveness of HBOT treatment in children with CP is anecdotal or based on poor quality trials. Reports of the success of the treatment may be based on three possibilities: (1) Although the lesion which has caused the CP is static, the clinical manifestations change. Motor skills of children with CP increase, albeit at a slow rate than in unaffected children, and these developments may be ascribed to the HBOT treatment rather than to ‘natural progress’. (2) There may be a subgroup of children with CP, perhaps a specific type of CP, who do improve more than would be expected over the period that a course of HBOT treatment is given. (3) Cognitive dissonance may play a part; i.e., it would be a very honest and brave person who would admit, after spending possibly thousands of pounds on HBOT treatment, that it had not worked. This tendency is compounded if funds for the treatment have been raised by voluntary donations and there has been media interest in the case (Essex, 2003).

It is concluded from the previous review of the use of HBOT for cerebral palsy that, while some case reports and before-and-after studies indicate improvements in function after HBOT, the best evidence to date indicates that HBOT and pressurized room air improved function to a similar degree, as shown in the observational studies, with no significant difference between groups. A proportion of children undergoing HBOT will experience adverse events, including seizures and the need for ear pressure equalization tube placement. But due to poor quality methods of assessment, estimates of the prevalence of these are uncertain.

2. Objective of the Study:

The objective of the study is to assess the effects of the hyperbaric oxygen therapy on the gross motor skills, sociality and awareness of children with cerebral palsy and mental handicap.

3. Methodology:

Study design: This is a pilot not controlled prospective study.

Procedures: The protocol for HBOT was 40 treatments of HBOT, at 1.3 atm increased gradually to 1.75 atm abs for 60 min. A Questionnaire was filled by the parents and the care provider who cares for these cases before subjecting them to 40 sessions of HBOT. At the end of the sessions, they were evaluated again, and the questionnaire was refilled again by the parents and the care provider, See Appendix (1).

Subject: The subjects of the study were 12 children with cerebral palsy and mentally handicapped, aging from 5 to 10 years, at special education center -Arab City for Comprehensive Care (ACCC)- in Amman. The study was under medical supervision from October, 2011 to March, 2012).

Data analysis: The researcher used the statistical processor from SPSS. The averages and standard deviations were calculated to estimate the behaviors of the MH with CP children before and after being subjected to oxygen treatment program. (T) test was conducted of the interrelated samples (paired –sample T Test), to examine differences between the average estimates of the behavior of MH with CP children before and after being subjected to oxygen treatment program.

Instruments: A questionnaire has been designed to consist a list of behaviors of children with cerebral palsy and mental handicap, to assess the effects of the hyperbaric oxygen therapy on each one. through literature review concerning the main characteristics of CP with MR children. There is an agreement between specialists on a number of characteristics. The most prominent one is the characteristics set by Hallahan and Kauffman (1994), as well as the characteristics from many studies and documents (Takeda et al, 2005; Soares et al, 2012; Beckung and Hagberg, 2000; Devinsky, 2008). The Total number of behaviors was 14.

Rating scales from 1 to 4 is identified to estimate the behaviors before and after treatment with HBOT.

Scale 4 indicates that the behavior is always occurs.

For scale 3, it indicates that the behavior is often occurs.

Regarding scale 2, it is mean that the behavior is some times occurs (a little).

Concerning scale 1, it is obvious that the the behavior is never occurs. See appendix 1.

4. Display of the Results and Discussion:

After processing the data statistically it was represented in table (1 and 2) below.

To answer the question (Is there a statistically significant effect for the oxygen therapy program at children with cerebral palsy and mental handicap at the level of $(0.05 = \alpha)$), the averages and standard deviations were calculated to estimate the behaviors of the children with cerebral palsy and mental handicap before and after being subjected to oxygen treatment program (See Table (1)).

Table (1)

The Averages and Standard Deviations of the Sample before and after being Subjected to HBOT

Before Treatment				After Treatment			
	N	Mean	Std. Deviation		N	Mean	Std. Deviation
Q1	12	0.9167	0.51493	Q1	12	1.9167	0.90034
Q2	12	1	0.95346	Q2	12	1.4167	0.9962
Q3	12	1.3333	0.88763	Q3	12	1.6667	1.07309
Q4	12	1.1667	1.19342	Q4	12	1.41670	0.90034
Q5	12	0.75	1.05529	Q5	12	1.0833	1.1645
Q6	12	1.3333	1.07309	Q6	12	1.5833	0.9962
Q7	12	1.3333	0.88763	Q7	12	1.4167	1.1645
Q8	12	0.9167	0.90034	Q8	12	1.3333	1.23091

Q9	12	0.8333	1.11464	Q9	12	1.1667	1.2673
Q10	12	1.8333	1.02986	Q10	12	2.25	0.86603
Q11	12	1.25	1.05529	Q11	12	1.25	1.05529
Q12	12	1.0833	0.9962	Q12	12	1.1667	0.83485
Q13	12	1.3333	1.30268	Q13	12	0.9167	0.90034
Q14	12	0.75	1.05529	Q14	12	0.4167	0.66856
TOTAL	12	1.1310	0.67615	TOTAL	12	1.3571	0.61821

The (T) test was conducted of the interrelated samples (paired –sample T Test), as shown in Table(2), Result of (T) test for the interrelated samples to examine differences between the average estimates of the behavior of children with cerebral palsy and mental handicap before and after being subjected to oxygen treatment program.

Table (2)

Result of (T) Test for the Interrelated Samples

The correlation coefficient	Statistical significance	Degrees of freedom	T	The arithmetic average	Number		
.781	0.097	11	1.815	1.1310	Before treatment	12	Pair coherent
				1.3571	After treatment	12	

As seen from Table (2), it is estimated that the average of behavior of children with cerebral palsy and mental handicap pre-treated with oxygen had reached (1.1310), which is less than the average estimates of behavior after treatment with oxygen, where the average is (1.3571). As can be noticed from Table (2), there is no statistically significant differences at the

level of ($0.05=\alpha$) between the average estimates of the behavior before and after treatment with oxygen, as the value of (T) (1.815). This indicates that the treatment with oxygen was not effective in improving the behavior of children with cerebral palsy and mental handicap.

5. Conclusion:

We conclude that there is no statistically significant value of HBOT although, apparently, the results were encouraging. From this study, we can easily infer that commercial claims that HBOT is magical treatment is not true. So the benefits in such cases is controversial, and lots of studies should be done with better methodology with more measures and equipment to measure the effectiveness of the treatment.

2- Recommendations:

Any future trials would need to consider appropriate, effective randomization and blinding of all participants and investigators, appropriate sample sizes with power to detect clinically important differences, appropriate and carefully defined comparator therapy, appropriate outcome measures including those previously reported, careful elucidation of any adverse effects and the cost-utility of the therapy types of CP, patients allowed into the study should be homogenous and should be carefully defined and regulated.

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Appendix (1)

Rating scales of behavior before and after treatment with oxygen for mentally handicapped children with cerebral palsy

Please markon the rating that fits the degree of child's behavior

Number	Behaviore	always occurs	often	A little	never
		3	2	1	0
	Responding to verbal commands				
	Responding to Visual stimuli				
	Responding to of audio stimuli				
	stereotyped behavior				
	Ability to balance,walking, and mobility				

	visualCommunicationwith others				
	Social interaction with others				
	ability to remember				
	Awareness of hazardous situations				
	Stable continuous sleep				
	Practice random behavior				
	Disruptive behavior				
	hyperactivity				
	aggressive behaviors towards others				

Student name: Age:

Evaluator name: :parent name

Date:.....