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Research Article

Evaluation of Role of Hyperbaric Oxygen Therapy in Children with Cerebral Palsy: Our Experience at Armed Forces Hospital, King Abdul Aziz Naval Base, KSA

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Abstract

Background: Hyperbaric Oxygen Therapy (HBOT) is medical treatment in which oxygen is used at an ambient pressure greater than atmospheric pressure for management of various clinical conditions in children like cerebral palsy, Bell's palsy and cerebral stroke. Although a palliative treatment but may be only hope for such patients.

Aims and Objective

1. To compare the efficacy and safety of HBOT in children with cerebral palsy with controls.
2. To make recommendation/suggestion for the pediatric staff awareness regarding HBOT.
3. To make recommendation for establishment of HBOT facility for cerebral palsy children.

Study Design: A double blinded randomized controlled trial.

Material and Methods

Inclusion Criteria: All children with clinical diagnosis of cerebral palsy were included in this study. They were divided into cases and controls after randomization.

Exclusion Criteria: Those with neurobehavioral disorders/abnormal brain MRI/chromosomal or genetic syndromes were also excluded from the study.

Dropped out: Seven (7) cases were dropped out of the studies due to other neurological disorder(ADHD/Autism) in which role of HBOT has not been clearly defined in the literature. This was a double blinded randomized case controlled clinical trial carried out to assess the efficacy and safety of hyperbaric oxygen (HBO_2) therapy in children with cerebral palsy.

Settings: This study was carried out at deep sea medicine unit of Armed Forces Hospital, KANB, Jubail, KSA. 97 Children aged 5 - 14 years with a clinical diagnosis of cerebral palsy who received HBOT were taken as cases and 103 children with cerebral palsy who did not received HBOT were taken as control (after randomization). Children who completed five (5) sessions of HBOT (in addition to physical therapy) starting from Study Period: June 2015 to June 2016 were taken as cases and children who received only physical therapy during same period were taken as control in this study. All children were given 5 sessions of HBOT.

Operational definitions: Each session comprising of 35 cycles, each cycle lasting for 60 minutes using 1.5 Atmospheric Absolute (Atmospheric pressure) = ATA, daily 5/7 over a period of 8 weeks).

The children were examined before and after each session of HBOT (Pediatrician, ENT and Ophthalmologist) and were assessed using ADL Scale score and modified GMFMS score, hearing and speech improvement in addition to safety index. The parents were interviewed for their satisfaction index using questionnaire.

Results: This data analysis showed 66.5% of the patients {(96% in (Cases) and 37% in (Controls)} showed improvement in neurological development (Gross motor functions measures scale) and 63% (95% in cases and 31% in control) in activity of daily livings score (self-reliance) and 46% (50% in cases and 42% in control) in parent's satisfaction index. While 64% showed improvement in hearing (37% in cases and 91% in control) but 30% showed improvement (33% in cases and 27% in control) in speech. Safety index was 93% (94% in cases and 95% in control). Data were analyzed using SPSS v20 and chi square test was used to analyzed these results. Statistical analysis showed these results are highly significant statistically (P value < 0.05).

Conclusion: Children with cerebral palsy showed significant improvement in neurological outcome (Improvements were noted in Gross motor functions, activity of daily living). The improvement was less remarkable in hearing, speech and parent's satisfaction index. Procedure was considered safe as only few minor side effects like ear ache and confinement anxiety were observed in some children.

Keywords: *Hyperbaric Oxygen Therapy (HBOT); King Abdul-Aziz Naval Base (KANB); Central Nervous System (CNS), Activity of Daily Living (ADL); Gross Motor Function Measures Scale (GMFMS); Parent Satisfaction Index (PSI)*

Introduction

Cerebral palsy is the name for a group of lifelong conditions that affect movement and co-ordination, caused result from problems within the developing brain that may occurs before, during or soon after birth. The symptoms of cerebral palsy are not are not usually obvious just after a baby is born. They normally become noticeable during the first two or three years of a child's life [1-16]. Cerebral palsy usually is secondary to asphyxia, intracranial hemorrhage and CNS infections (Meningitis) result from cerebral palsy includes asphyxia, intracranial hemorrhage and CNS infection (Meningitis). There is currently no cure for cerebral palsy, but treatments available are to improved quality of life and promote independent living. but treatments are available to help people with the condition have a normal and improved quality of life and promote independent living. Present treatments includes pharmacology, physiotherapy, speech therapy to improve communication, occupational therapy and surgery to treat movement or growth problems. Selective rhizotomy is the most effective treatment to reduce spasticity in most but not all types of cerebral palsy [2]. Hyperbaric oxygen therapy (HBOT) is medical treatment in which an ambient pressure greater than sea pressure is used. HBOT is the medical use of oxygen at an ambient pressure higher than atmospheric pressure. The equipment required for hyperbaric oxygen treatment consists of a pressure chamber, which may be of rigid or flexible construction, and a means of delivering 100% oxygen. Operation is performed to a predetermined schedule by trained personnel who monitor the patient and may adjust the schedule as required. This therapy (HBOT) has been used in various parts of the world with variable results. The application of HBO to the therapy of various human diseases developed over a period of 300 year. Like most of medicine, the basis of these applications was and continues to be pragmatic in nature, and involves uncritical and untested judgments. The possibility of risks has been understated and possible benefits have been overstated [1].

Deep sea medicine unit is established at Armed Forces Hospital, King Abdul Aziz Naval base, Jubail since 20 years and pediatric patients are being treated since 8 years with diagnosis of cerebral palsy, learning disability, bell's palsy and poorly healing wounds (post-traumatic and diabetics). Tentative evidence shows a possible benefit in cerebro-vascular diseases [3]. The clinical experience and results so far published has promoted the use of HBO therapy in patients with cerebrovascular injury and focal cerebrovascular injuries. However, the power of clinical research is limited because of the shortage of randomized controlled trials [6]. This study was conducted to bridge the knowledge gap and to produce scientific evidence regarding efficacy, side effects and safety of HBOT.

Material and Methods

This study was carried out at deep sea diving & medicine unit, AFH-KANB, Jubail, KSA. 200 children cases (n = 96) and control (n = 104) with clinical diagnosis of cerebral palsy were enrolled in this study after randomization using SPSS V20 irrespective of gender. Seven (7) cases were dropped out due to other neurological disorders like ADHD and Autism. Finally, 90 cases and 103 controls were included

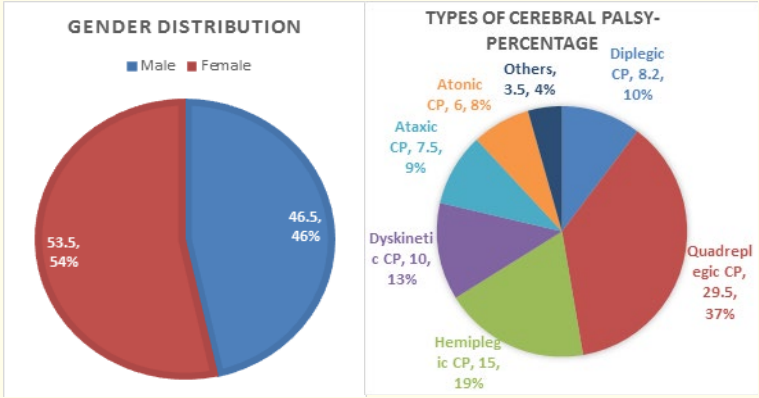
in this study. Cases received hyperbaric oxygen therapy (HBOT) and controls did not receive HBOT. All cases underwent 5 cycles of HBOT. Each cycle comprised of 40 sessions of HBOT over a period of 2 months, one session per day, 5 days per week for 8 weeks. Each session consists of 60 minutes and 100% oxygen at @1.5 ATA in specialized HBOT chamber was delivered via a hood in the multi-place chamber. All children underwent a complete physical examination (by pediatrician, ENT otolaryngologist and ophthalmologist) before and after the session with a special focus on the central nervous system (CNS), ears and respiratory system. During the trial, a pediatrician recorded the improved results using Modified GMFMS Score sheet, Barthel Index of activity of daily living (ADL) score sheet and hearing, speech (can be deleted) improvement in all children of both groups. In modified GMFMS, score more than 5 was taken as improvement, higher the score higher the improvement while in ADL score less than 16 was considered as improvement taken as improvement while score more than 17 as no improvement, so lesser the score higher the improvement. Parents satisfaction index (PSI) using questionnaire was also recorded. All adverse health events occurring during the course of the study (barotrauma Barotrauma, oxygen toxicity, confinement anxiety, ocular defect) corresponded to the adverse outcomes was recorded as a measure of safety of HBOT. These events could occur during a particular session or in between sessions. A safety score 0-2 was taken as measure of safety of the intervention (HBOT), lesser the score safer is the procedure.

Data analysis

It was based on an intention-to-treat approach. All children included are reported in the results. Chi-square test was used to evaluate the result of our study. Level of statistical significance was set at 0.05 (type 1 error) and analyses were done with SPSS v20.In this study evaluation of role of HBOT was focused on two aspects; positive effects like decrease in incidence and severity of long term complications (gross motor functions, activity of daily living Gross motor functions, Activity of daily living etc.) and negative effects like cost, side effects and complications.

Results

Two hundred children were included in the study 48.5% (n = 97) as cases and 51.5% (n = 103) as control using randomization (Table 1). Seven children were dropped out of the study due to other neurological disorders so finally 90 cases (45%) and 103 (51.5%) controls completed the study. General differences in study groups (case and control) like age, gender, clinical types of cerebral palsy and parameters used to assess efficacy and safety of HBOT are shown in table 1 and 2. Statistical analysis (by chi square test) are shown in table 1. Pie, line and bar charts are also shown to highlight frequency distribution of variables in both groups.



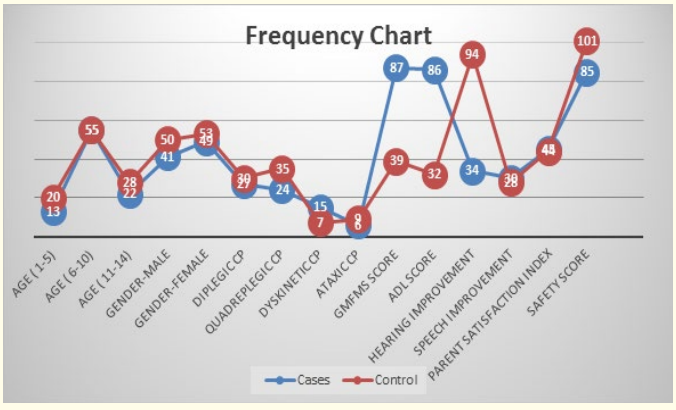
Gender distribution showed 46.5% (n = 93) were male and 53.5% (n = 107) female child between the case and control groups and this again was statically insignificant as P value 0.895. Age distribution was 16.5% (1 - 5 years, n = 33), 57% (6 - 10 years, n = 114) while 26.5% (53) were in age group 11 - 14 years (Table 1).

	Parameters	Variables	Frequency	Percent	Valid Percent	Cumulative Percent
1	Age	1 - 5 years	33	16.5	16.5	16.5
		6 - 10 years	114	57	57	73.5
		11 - 14 years	53	26.5	26.5	10
2	Sex	Male	93	46.5	46.5	46.5
		Female	107	53.5	53.5	53.5
3	Groups	Cases	90	45	45	45
		Control	103	51.5	51.5	51.5
4	GMFM	No Improvement	67	33.5	33.5	33.5
		Improvement	126	63	63	63
5	ADL	Improvement	118	59	59	59
		No improvement	75	37.5	37.5	37.5
6	Hearing	Responsive	128	64	64	64
		Unresponsive	65	32.5	32.5	32.5
7	Speech	Intelligent	58	29	29	29
		Incomprehensible	134	67	67	67
		None	1	0.5	0.5	0.5
8	Satisfaction Index	Not Satisfied	89	44.5	44.5	44.5
		Satisfied	104	52	52	52
9	Safety Index	Safe	186	93	93	93
		Unsafe	7	3.5	3.5	3.5

Table 1: *Chi Square Test.*

Chi square test results showed this difference in age and gender in both groups is statistically insignificant as P value was 0.511.

As for diagnosis is concerned spastic diplegia (28.5%, n = 57) and spastic quadriplegia 29.5 %(n = 59) were the most common type, followed by spastic hemiplegia (15%, n = 30) and dyskinesia cerebral palsy (10%, n = 20). Rest were ataxic cerebral palsy (7.5%, n = 15), atonic cerebral palsy (6%, n = 12) and others (3.5% (n = 7) respectively (Figure 2). Statistical analysis showed this difference was insignificant as P value was 0.537 (Table 2).

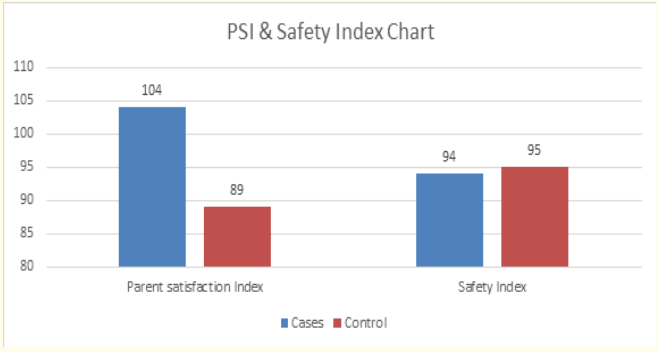


No	Variable	Value	Df	Asymp significances
1	Age	3.287	4	0.511
2	Gender	0.222	2	0.895
3	Type of CP	4.085	5	0.537
4	GMFMS	275.938	4	.000
5	ADL	287.120	4	.000
6.	Hearing	263.744	4	.000
7	Speech	201.724	6	.000
8	Safety	201.860	4	.000
9	PSI	201.062	4	.000

Table 2: *Chi Square Test.*

As for the results are concerned, data showed improvement in GMFMS 66.5% (n = 126) (96% and 37% in group 1 and 2), while 33.5% did not show any improvement (n = 67) P values was 0.000, while in Activity of daily living (ADL) 63% (95% and 31% in Group 1 and 2 respectively) showed improvement while 37.5% did not showed any improvement. Statistical analysis showed p value which was statistically significant (Figure 2). As for hearing and speech are concerned, statistical analysis showed some improvement (lesser as compared with motor improvement) in 64% (37% and 91% in group 1 and 2) and 30% (33% and 27% in Group 1 and 2) of the patients respectively while 34% and 70% did not showed any improvement with a p values of 0.000, meaning by statistically significant. As for parent satisfaction index (PSI) is concerned 54% (50% and 42% in group 1 and 2) were satisfied but 46% were unsatisfied P value (0.000) (Figure 2).

As for safety is concerned 94.5% (94% and 95% in case and control groups) of patient did not had any significant side effect while only 3.5% showed minor side effects like earache and confinement anxiety with a P value of 0.000 suggesting statistically significant results.



Discussion

Results of this study showed that neither the difference in age and gender nor was the difference in clinical type of cerebral palsy statistically significant as for efficacy and safety of HBOT is concerned. Our results showed significant improvement in modified GMFM score, ADL score and to a lesser extent in hearing and speech. The GMFMS improvement has also been documented in other study in which score increased by 2.9% in the children on hyperbaric oxygen [15]. A retrospective case study including 6 patients also reported that HBOT is effective [7]. Treatment with hyperbaric oxygen has also been shown to reduces mortality and neurological sequelae in term neonates with hypoxic-ischemic encephalopathy [10]. There was also significant improvement in parent satisfaction index. Two fair-quality uncontrolled studies (one time-series, one before-after) found improvements in functional status comparable to the degree of improvement seen in both groups in the controlled trial [9]. All these results were statistically significant and has positive clinical cor-

relation in our studies. As for side effects are concerned, most of patients did not had any side effect related to HBOT. HBOT was found to be safe in our study. Few patients did develop minor side effects like earache and confinement anxiety during the study. Major side effects like pneumothorax, oxygen and CNS toxicity were not observed [3]. Short-term exposure to HBOT at medium level pressure (1.75 ATA) was responsible for a significant increase of middle ear barotrauma compared to children that received very low external pressure (1.3 ATA) [12]. Statistical analysis showed these differences in side effects were significant. These results are the same as shown in other studies [5,10]. Although we dropped out children with diagnosis of Autism or ADHD from our studies but there are reports which showed significant improvement in behavior but not in other cognitive areas [6].

Pediatricians are not always aware of the potential benefit of HBO in the treatment of the diseases for which it is indicated, whereas the HBO staff are not always familiar with the specific management requirements of the pediatric patient, especially those who are critically ill. The physician inside the chamber caring for a ventilated, critically ill infant or child should be familiar with this type of treatment, ventilator settings, and eventual intubation or reintubation of the patient, as well as with medication man [3]. There is a fundamental need for pediatricians and institutions engaged in pediatric health care to be actively involved in the decision-making process for HBO therapy in the pediatric patient. Wise decision making, based on an understanding of the known benefits of this modality of treatment, may reduce the mortality and severe sequelae of those diseases for which HBO is indicated [3]. Although the results of this trial are encouraging but it is hard to draw a definite conclusion about the role and effectiveness of HBOT therapy because of the low number of cases [4] and being a single center study. A large scale multicenter RCT should be done before final recommendation can be made [14].

Conclusion

This study showed that hyperbaric oxygen therapy is quite safe and effective in children with cerebral palsy so its use should be considered (wherever facility is available) along with other therapies like physical therapy, medication, psychotherapy wherever needed. Earlier institution of this modality acute neurological problems like Bell's, palsy and acute stroke (Ischemic). Only minor side effects like earache and confinement anxiety was noted in few children and were similar in both groups. Our study also shows that exposure to low hyperbaric pressure (1.5 ATA) reduces the chances of serious/significant side effects.

Recommendations

1. We also suggest a large scale multicenter RCT study needs to be conducted to verify results (efficacy and safety) of hyperbaric oxygen therapy (HBOT).
2. We also suggest pediatric staff in particular and medical staff in general regarding this new modality of treatment in children with cerebral palsy.
3. We also suggest such facility may be created for children with cerebral palsy.

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16. Cerebral Palsy-NHS choice.

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