

Finally, we were unable to determine whether treatments of asthma, or sleep disturbance could affect manifestation of DLD or vice versa.

Recommendation:

1. More studies on side effects in children are needed to cover other pressure- related complications.
2. Standardized guidelines on HBOT pediatric usage, i.e., number and duration of sessions.
3. More studies are needed on how to make HBOT affordable for the low- income population.

Conflict of Interest:

There is no conflict of interest.

Ethical Consideration:

1. Written permissions for conducting the study in the HBOT Unit were taken from children at the Special Needs Center, Ain Shams University, Nasser's Institute, Alexandria.
2. Verbal consent was taken from parents of the studied children.

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tympanostomy tubes (Presswood et.al 1994). We found that mechanical ventilation was not associated with an increased incidence of MEB, which might be explained by deep sedation of the patients while HBO₂ was performed, as it may have helped peristaphylin muscle relaxation and unconscious pressure equalization.

Other factors explaining this difference might be that the Presswood series included patients treated for head and neck surgical and radiation side effects, whereas our series included only emergency conditions without any patients specifically treated for a head and neck condition.

This study focuses on following up the children on HBOT already to evaluate the prevalence of the most common side effects of HBOT among the pediatric population. Besides HBOT complications follow up, this study aims to evaluate many variables that may be related to the quality of life (QoL) in children on HBOT.

Targeting the pediatric population, the ages of concluded participants were 6 years and 10 with a mean of about 7 years and 5 months, 69% of children were males and 31% were females. This makes findings in this study more applicable to male children.

More than half of the children participating in this study were underweight (59%) and having a height less than normal (61%). This could be due to their medical conditions or bad nutrition. However, regarding their medical diagnoses and that 58% have microcephaly, most of these children have body measurements below normal values due to their medical conditions.

Children's quality of life was expressed in this study by the parent's educational status, parents' occupation, and crowding index. Most parents were illiterate or had low education, together make up more than 50%; despite this, they were approving their children to have HBOT. This means that HBOT is starting to be widely accepted as a treatment option even in low educational communities.

However, we must do more to make people aware of the importance and side effects of this type of treatment. On the other hand, nearly half of the children's families had high income as parents have a high profession. Besides, 41% of families and 49% of families had a crowding index of 2 and 3 respectively; which means having a high quality of life. These two findings reflect the cost-dependent choice of HBOT as a treatment option. More studies should be made on "how to make HBOT less costly".

The satisfaction survey on participants' parents about HBOT revealed that only 18% are unsatisfied. Excluding only the unsatisfied feedbacks (18%), we have 82% of parents accepting HBOT as a treatment choice for their children. Excluding neutral feedback (35%), making up 47% satisfied and highly satisfied together. The 47% is consistent with that about half of the children's families have a high income.

The medical conditions of participants in this study are 5 groups; the most prevalent conditions are learning disabilities (38%), cerebral palsy (36%), and autism (20%). Only 4% had attention deficit hyperactivity disorder (ADHD) and 2% had non-healing wounds.

Unlike expected the minority was a non-healing wound, which is one

of the most recommended indications of HBOT.

Regarding concurrent administration of other therapy with HBOT, all children already were on concurrent therapy with HBOT. A good point here is the present medical conditions require HBOT as adjuvant therapy, not a monotherapy, which reflects the good awareness of healthcare providers.

At the end of the study, the mean number of HBOT sessions attended by our participants was 22 sessions. However, because the standard deviation was large (13.3), the number of sessions ranged between 2 and 57 sessions. This makes the interpretation of findings unsure and not consistent.

Middle ear barotrauma is the most frequent side effect of HBOT. Assessment of middle and inner ear condition has undergone 2 methods in this study, otoscopy, and tympanometry.

Otoscopy of the children revealed that more than half of the children (56%) were TEED0, i.e., had normal and intact TM. 24% were TEED1, i.e., had mild injection/ retraction of TM, which means also intact TM, making up 80% of children who had no MEB. The sum of patients with TEED1 and TEED2 in this study was 34%. Moreover, 6% had TM rupture.

However, these findings are not consistent with recent studies on adults and children such as Heyboer et.al. Who had 84% of patients with TEED1 and TEED2; and had no TEED5, i.e., TM rupture, at all despite the larger number of participants in his study.

The conflict between this study and Heyboer et.al. can be attributed to the age difference. In this study, ages did not exceed 10 years. This finding argues that young age is more liable to TM perforation and MEB than adults are.

The tympanometry, on the other hand, showed interesting findings. The interpretation of tympanograms of children revealed that 6% had low middle ear pressure, which is consistent with 6% TEED5 in otoscopy. 67% had normal middle ear pressure, which is consistent with the results of TEED0.

It is reported that a significant increase in the middle ear barotrauma in children with cerebral palsy using HBOT compared with patients receiving low external pressure. In addition, among autism spectrum patients a minor degree of barotrauma occurred.

Conclusions:

HBOT is generally safe in children, but the incidence rates of pressure-induced side effects are high. Ear barotraumas are a wide range of complications that are tolerable, like pressure sensation, and reversible in many cases. However, caution should be taken to prevent severe middle ear damage. For the pediatric population, HBO should be restricted to evidence-based and life-saving indications.

Limitations of the study:

There were some limitations to this study. The cross-sectional design prevents any conclusions from being made on causality or direction of association.

years (7.4± 6.7) yr. it included 69 boys (69%), girls 31 (31%) Table (1).

Table (1) Demographic characteristics

Variable		Mean ± SD	Range
Age (Months)		7.4y ± 6.7	72-120
Variable		N	%
Sex	Male	69	69.0%
	Female	31	31.0%

Table (2) Distributions of the presented participants according to their diagnosis

		N	%
Diagnosis	C.P.(cerebral palsy)	36	36.0%
	L.D.(learning disability)	38	38.0%
	Autism	20	20.0%
	ADHD. (attention deficit hyperactivity disorder)	4	4.0%
	Wound	2	2.0%

Table (3) Comparison between pre HBOT& post HBOT as regards TEED

TEED		pre	post	X2	P Value	Sig.
ADHD	Normal	6 (100%)	4 (66.7%)	2.40	0.301	NS
	Tympanic Membrane Injection Or Retraction	0	1 (16.7%)			
	Hymotympanum	0	1 (16.7%)			
Autism	Normal	20 (100%)	10 (50%)	13.33	0.010	S
	Tympanic Membrane Injection Or Retraction	0	5 (25%)			
	Slightly Hemorrhagic	0	2 (10%)			
	Grossly Hemorrhagic	0	2 (10%)			
	Tympanic Membrane Perforation	0	1 (5%)			
LD	Normal	37 (100%)	22 (59.5%)	18.81	<0.001	HS
	TMJ Injection Or Retraction	0	10 (27%)			
	Slightly Hemorrhagic	0	4 (10.8%)			
	Tympanic Membrane Perforation	0	1 (2.7%)			
CP	Normal	35 (100%)	18 (51.4%)	22.45	<0.001	HS
	TMJ Injection Or Retraction	0	8 (22.9%)			
	Slightly Hemorrhagic	0	4 (11.4%)			
	Grossly Hemorrhagic	0	1 (2.9%)			
	Tympanic Membrane Perforation	0	4 (11.4%)			
Wound	Normal	2 (100%)	2 (100%)	-	-	-

As for TEED scores all groups showed significantly higher incidence of side effect after HBOT compared with their pre- HBOT TEED scores. TMJ retraction was significantly higher after HBO in all population with the highest percentage among LD patients, while the tympanic membrane perforation was significantly higher among CP group; table (3).

Discussion:

Hyperbaric oxygen therapy (HBOT) represents a good treatment option for tissue hypoxic condition. It improves tissue oxegantation by providing high- pressure oxygen which increases tissue oxygen tensions in addition it can reverse the hypoxic state of tissues wich improves the healing power. According to existing studies, HBOT is safe and tolerated in adults and children. However, there are some adverse side effects and serious complications; which can be classified into three categories: side effects due pressure, side effects because of oxygen toxicity, and psychological side effects, such as anxiety, compartment anxiety, and claustrophobia in some people. (Sadri& Cooper, 2020)

On reviewing available literature, it is easy to notice that little effort has been exerted to study the prevalence of HBOT complications in children.

In contrast with previous fndings, we found no association between age or gender and middle ear barotrauma (MEB).

Difficulties with equalizing pressure were associated with MEB, while patients who did or did not perform a Valsalva had the same MEB incidence. This could be explained by a number of patients performing ineffective Valsalvas, who would be at higher risk for MEB; this is on par with previous fndings on Eustachian tube function (Fernau, et.al., 1992)

and higher risk of MEB in patients unable to auto- infate the middle ear (Beuerlein, et.al. 1997).

Middle ear barotrauma is one of the most common side effects of HBO₂ (Plafki, et.al. 2000); reported incidences range from (8- 68.7)% and up to 91%.

Known risk factors for MEB include female sex; older age (Fitzpatrick, et.al. 1999), artificial airways (intubation) (Presswood et.al. 1994), and history of Eustachian tube dysfunction (Fernau, et.al. 1992) or the inability to auto- inflate the middle ear. (Beuerlein, et.al. 1997)

The successful equalization of pressure by inflating the middle ear has been reported to be protective (Beuerlein, et.al. 1997), whereas the prophylactic use of nasal decongestants has not. (Carlson, etal. 1992)

In previous findings, we found no association between age or gender and MEB. Difficulties with equalizing pressure were associated with MEB, while patients who did or did not perform a Valsalva had the same MEB incidence.

This could be explained by a number of patients performing ineffective Valsalvas, who would be at higher risk for MEB; this is on par with previous findings on Eustachian tube function (Fernau, et.al., 1992) and higher risk of MEB in patients unable to auto- inflate the middle ear. (Beuerlein, et.al. 1997)

Repetitive treatments increased the risk for MEB, whereas the treated condition (which determined treatment depth) did not influence MEB incidence.

In 1994 Presswood reported that 94% of the intubated patients developed a middle ear complication, and 61% required placement of

Introduction:

Hyperbaric oxygen therapy (HBOT) is a treatment modality in which patient enters a special chambers with controlled levels of oxygen (O₂) at higher atmospheric pressure, and breathes 100% O₂. This special chamber may be a monoplace or a multiplace chamber that is pressurized to more than 1.4 atmosphere absolute (ATA). Treatment sessions lasts for 45 minutes to 2 hours long, depending on the indication and medical condition. It may be performed up to three times daily (Jeter& Wong, 2020).

In a normal subject, HBO at 3 ATA increases arterial oxygen tensions (PaO₂) from 100 to 2000 mmHg and tissue oxygen tensions from 55 to 500 mmHg (Kim et. al., 2020).

Currently, they approved up to fourteen indications for HBOT. Yet, a much greater number of conditions in which HBOT can be adjuvant therapy is under investigation. Examples of these investigational conditions are autoimmune diseases, Alzheimer's disease, and other cognitive conditions, cerebral palsy, autism, and attention deficit hyperactivity disorder (Choudhury, 2018).

The safety of both patients and attendants is a very vital point regarding HBOT, because of the flammability of oxygen and the high pressure that can cause barotraumas.

HBOT is a relatively safe option for a variety of medical conditions. However, it exhibits some adverse side effects and serious complications which can be categorized as: side effects because of pressure including ears, sinus, teeth, lungs, and bowel; side effects because of oxygen toxicity involving pulmonary, neurologic, and ophthalmologic; and psychological effects, such as anxiety, compartment anxiety, and claustrophobia in some people.

Extensive search in the existing literature reveals that HBOT usage in the pediatric population is not fully covered and need more evidence on usage and safety. This study is a follow- up study that aims to study the incidence rates of audio logical side effect of HBOT in children aged 6 to 10 years. We will try to answer the question: "How much is HBOT safe to use in the pediatric population? And how frequent are its side effects in them?".

Our study aimed to investigate the safety of HBOT in the pediatric population by studying its most common side effects, barotrauma, in children aged 6 to 10 years.

Subjects:

The study was done between October 2018 and January 2022 at Special Needs Center which is affiliated with the Faculty of Childhood Postgraduate Study, Nasser's Institute, Alexandria Hospital of Diabetic Foot.

Random one hundred children were enrolled in this study, their ages ranged from (6- 10) years. These cases evaluated twice (pre HBOT sessions and post HBOT sessions). All parents agreed to undergo the assessment and had informal consent. The study was approved by ethical committee of faculty of postgraduate childhood studies (FPGCS), Ain

Shams University, and protocol no. RHDIRB2020110401.

1. Inclusion criteria:

- All children age ranged (6- 10) years old.
- The children who enrolled in the study came to receive HBOT treatment for first time.
- The children took 20 regular session at least.
- Children were received adequate environmental stimulation.
- The Arabic language was the mother tongue language and the only used language in the child's environment.

2. Exclusion criteria:

- The presence of Ear problems (conductive deafness, drum problems).
- Abnormal Brain MRI.
- Chromosomal or genetic syndromes.
- Depression.
- Epilepsy.
- Patients on long- term drug therapy regimen.
- Children with upper or lower respiratory tract infection were also excluded from the study, any medical, psychological illness, or sensory impairment.
- No genetic or structural abnormalities.

Methods:

The children who were fulfilling the criteria mentioned above will be subjected to:

- Formal history taking and pediatric examination were done, including general and local chest examination.
- Ear examination: To assess the tympanic membrane and middle ear. It includes the following: Modified TEED score, using an otoscope.

Grade	Findings On Otoscope
0	Normal Examination
1	TM Injection Or Retraction
2	Slightly Hemorrhagic
3	Grossly Hemorrhagic TM
4	Hemotympanum
5	TM Perforation

Complete phoniatric evaluation, done by a phoniatist, and assessing language abilities detect delayed language development by Modified preschool language scale- four (Arabic edition).

Statistical Analysis:

Collected data will be entered and analyzed on PC computer and presented using appropriate statistical tests by SPSS version 20 statistical data program. Numerical data were summarized using means and standard deviations or medians and ranges. Data were explored for normality using Kolmogorov- Smirnov test and Shapiro- Wilk test. Chi-square tests was used to examine the relation between qualitative variables. P- values ≤ 0.05 were considered significant.

Results:

Random one hundred children were enrolled in this study after fulfilling the criteria mentioned above. Their age ranged between (6- 10)

Study of Some Side Effects of Hyperbaric Oxygen Therapy in Children

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Summary

Aim: The current work aimed to identify the safety of HBOT in the pediatric population by studying its most common side effects, barotrauma, in children aged 6 to 10 years.

Subjects& Methods: The follow- up study was done between October 2018 and January 2022 at Special Needs Center which is affiliated with the Faculty of Childhood Postgraduate Study. Random one hundred children were enrolled in this study, their ages ranged from 6- 10 years. prospective follow- up study These cases evaluated twice (pre HBOT sessions and post HBOT sessions). Modified TEED score, using an otoscope was applied.

Results: As for teed scores all groups showed significantly higher incidence of side effect after HBOT compared with their pre- HBOT teed scores. TMJ retraction was significantly higher after HBO in all population with the highest percentage among LD patients, while the tympanic membrane perforation was significantly higher among CP group.

Conclusion: HBOT is generally safe in children, but the incidence rates of pressure- induced side effects are high. Ear barotraumas are a wide range of complications that are tolerable, like pressure sensation, and reversible in many cases. However,.

Recommendations: caution should be taken to prevent severe middle ear damage. For the pediatric population, HBO should be restricted to evidence- based and life- saving indications.

Keywords: Barotrauma- Hyperbaric oxygen- TEEDS.

دراسة لبعض الآثار الجانبية للعلاج بالأكسجين تحت الضغط في الأطفال

مقدمة: الأكسجين تحت الضغط هو بديل علاجي للحالات المرضية التي تعاني من نقص التغذية بالأكسجين والتي تتحسن مع الضغط العالي للأكسجين، هذا النوع من الأكسجين يتم تقديمه داخل منشآت صحية خاصة بهذا الغرض تدعى حجرات الضغط العالي. استخدام الأكسجين تحت الضغط آمن نسبياً للأعراض العلاجية المختلفة ولكن هناك بعض المشكلات المصاحبة لاستخدامه. هذه المشكلات تشمل مشاكل الضغط العالي وتأثيرها على الأذن، الجيوب الأنفية، الرئتين، تم عمل كشف انف واذن واشعه عاديه علي الصدر لجميع الحالات بالإضافة إلى المشكلات النفسية كالقلق وخوف الأماكن المغلقة.

الاهداف: تهدف هذه الدراسة لتحديد مدى انتشار الأعراض الجانبية للأكسجين تحت الضغط وتقييم أمانه على الأطفال من سن ٦ إلى ١٠ سنوات.

المرضى والطريقة: قمنا بدراسة مدى انتشار الأعراض الجانبية للأكسجين تحت الضغط بين الأطفال الذين تتراوح أعمارهم بين ٦ إلى ١٠ سنوات. ضمت هذه الدراسة ١٠٠ طفل، من بينهم مرضى الطيف التوحدي واضطراب فرط الحركة والشلل الدماغي والتأخر الدراسي، والجروح. قمنا بعمل دراسة تجريبية من أجل: تحديد صلاحية نموذج الأسئلة، وعمل مقابلة طبية لجمع المعلومات الطبية اللازمة وكذلك قمنا بعمل الفحص الطبي الإكلينيكي، مقياس TEED ومقياس بطلة الأذن. قمنا بتجميع البيانات وترميزها وإدخالها لبرنامج SPSS مستخدمين مقياس Chi- Square.

النتائج: طبقاً لمقياس TEED فإن ٥٦% كم المرضى كان لديهم نتائج صحية، ٢٤% منهم كان لديه احتقان أو تقلص لطبلة الأذن ١٠% كان لديهم نزيف بسيط و٦% كان لديهم ثقب بطلة الأذن و٣% لديهم نزيف صريح بطلة الأذن وأخيراً ١% لديهم دم بتجويف الأذن. متوسط مقياس هاملتون لقياس القلق كان ٣,١ من بين حالات الدراسة، ٩٨% كان مصاباً بدرجة قليلة من القلق، ٢% اصيبوا بدرجة متوسطة.

الاستنتاج: الأكسجين تحت الضغط آمن بشكل عام ولكنه مصحوب ببعض الأعراض الجانبية منها إصابات الأذن يمكن تجنبها ويمكن شفاؤها. ويجب استخدام الأكسجين تحت الضغط بين الأطفال طبقاً لأحدث التوصيات.