The Egyptian Journal of Medical Human Genetics (2014) **15**, 155–162

Ain Shams University

The Egyptian Journal of Medical Human Genetics

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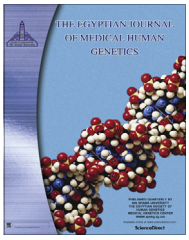

ORIGINAL ARTICLE

Study the effect of hyperbaric oxygen therapy in Egyptian autistic children: A clinical trial

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Received 13 December 2013; accepted 20 January 2014
Available online 20 February 2014

KEYWORDS

Autism;
Hyperbaric oxygen therapy;
Oxidative stress;
Behavior

Abstract *Background:* Numerous studies of autistic individuals have revealed evidence of cerebral hypoperfusion, neuroinflammation, gastrointestinal inflammation, immune dysregulation, oxidative stress, relative mitochondrial dysfunction, and neurotransmitter abnormalities. Many of these findings have been correlated with core autistic symptoms. For example, cerebral hypoperfusion in autistic children has been correlated with repetitive, self-stimulatory and stereotypical behaviors, and impairments in communication. Specifically, hyperbaric oxygen therapy (HBOT) has been used and can compensate for decreased blood flow by increasing the oxygen content of plasma and body tissues. The aim of this work was to study the effect of hyperbaric oxygen therapy in autistic Egyptian children.

Patients and methods: This prospective clinical trial study was conducted on 20 children diagnosed as autism based on DSM-IV-TR criteria (diagnostic and statistical manual of mental disorders, 4th edition criteria, text revised). All patients received at least 20 sessions of hyperbaric oxygen therapy. Sessions were done at pressure 1.5 ATA (atmosphere absolute) with 100% oxygen concentration each lasting for 1–1.5 h either in multiplace chamber or monoplace chamber. MRI Perfusion of the brain was done before and after at least 20 HBOT sessions only for 6 cases.

Results: There was a statistically significant increase in the ratio of regional cerebral blood flow (RCBF) to white matter after HBOT in different brain regions when compared to their levels before HBOT.

Conclusion: HBOT is a treatment that has recently become quite popular in the autism spectrum disorder (ASD) community. Its benefits cross a wide range of autistic traits as: improved language,

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Peer review under responsibility of Ain Shams University.

ELSEVIER Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.ejmhg.2014.01.004

increased awareness, behavior and socialization by affecting the pathophysiological findings in autism.

1. Introduction

Autism is a neuro-developmental disorder in the category of pervasive developmental disorders, characterized by problems of social communication, inflexible language and behavior, and repetitive sensory-motor movements [1]. Numerous studies of autistic *individuals* have revealed evidence of cerebral hypoperfusion, neuro-inflammation, gastrointestinal inflammation, immune dysregulation, oxidative stress, relative mitochondrial dysfunction, neurotransmitter abnormalities, impaired detoxification of toxins, and impaired production of porphyrins. Many of these findings have been correlated with core autistic symptoms. For example, cerebral hypoperfusion in temporal regions and other brain areas in autistic children has been correlated with repetitive, self-stimulatory and stereotypical behaviors, and impairments in communication [2,3].

Hyperbaric oxygen therapy (HBOT) might be able to improve each of these problems in autistic individuals [4]. Specifically, HBOT has been used and can compensate for decreased blood flow by increasing the oxygen content of plasma and body tissues. HBOT has been reported to possess strong anti-inflammatory properties and has been shown to improve immune function. There is evidence that oxidative stress can be reduced with HBOT through the upregulation of antioxidant enzymes. HBOT can also increase the function and production of mitochondria and improve neurotransmitter abnormalities. In addition, HBOT upregulates enzymes that can help with detoxification problems and impaired production of porphyrins in autistic children which might affect the production of heme, so, HBOT might help to overcome the effects of this problem [5]. HBOT has been shown to mobilize stem cells from the bone marrow to the systemic circulation. Recent studies in humans have shown that stem cells can enter the brain and form new neurons, astrocytes, and microglia. It is expected that amelioration of these underlying pathophysiological problems through the use of HBOT will lead to improvements in autistic symptoms [6]. The aim of this work was to study the effect of hyperbaric oxygen therapy in autistic Egyptian children.

2. Patients and methods

This prospective clinical trial study was conducted on twenty children diagnosed as autism based on DSM-IV-TR criteria (diagnostic and statistical manual of mental disorders, 4th edition criteria, text revised) who attended for follow up at the Psychiatry Clinic, Children Hospital, Ain Shams University. The patient's group included 17 males and 3 females, their ages ranged from 2 to 9 years (mean age 5.6, SD $\pm$2.11 years).

Children were allowed to continue all current therapies during HBOT.

All patients were subjected to the following:

(I) Detailed history taking with special emphasis on:Onset, course, duration of the disease, age, sex of the patient, antenatal, natal, postnatal history, developmental history (both mental and motor) and accurate details of cognitive abilities and gross and fine motor function, past history and family history concerning similar condition or any psychological or mental disorders. Also history of major childhood illnesses, surgery, injuries, diet, and medication was taken.

(II) Thorough clinical examination with special emphasis on neurological examination.

(III) Psychiatric evaluation includes:

(1) Confirmation of diagnosis using DSM-IV-TR criteria [7,8].

(2) Childhood autism rating scale (CARS) was done before and after at least 20 sessions of HBOT [9].

The scale is used to observe and subjectively rate 15 items. Relationship to people, imitation, emotional response, body use, object use, adaptation to change, visual response, listening response, taste–smell–touch response and use, fear and nervousness, verbal communication, non-verbal communication, activity level, level and consistency of intellectual response and general impressions. Each of the fifteen criteria listed above is rated with a score of Normal for child's age, mildly abnormal, moderately abnormal, and severely abnormal. Total CARS scores range from 15 to 60, score of 30 is considered the cutoff level for a diagnosis of autism on the mild end of the autism spectrum (done before and after at least 20 sessions of hyperbaric oxygen therapy).

(3) Autism treatment evaluation checklist (ATEC) was done before and after at least 20 sessions of HBOT [10].

The ATEC is a questionnaire that was developed by the Autism Research Institute to evaluate the treatment efficacy in autistic individuals. It consists of four subscales labeled: Speech/Language/Communication, Sociability, Sensory/Cognitive Awareness, and Health/Physical/Behavior. The scores are weighted according to the response and the corresponding subscale. The higher the subscale and total scores, the more impaired the subject [11]. ATEC is used in some studies as an outcome measure [12]. It is designed to allow parents and physicians to assess the outcomes of certain treatments commonly used in autistic individuals. In this study, scores were calculated for the total score and the four separate subscales (done before and after at least 20 sessions of hyperbaric oxygen therapy).

(IV) Hyperbaric oxygen therapy:

All patients received at least 20 sessions of hyperbaric oxygen therapy (8 patients received 20 sessions, one patient received 30 sessions and 11 patients received 20 sessions followed by another 20 sessions after 2 weeks). Sessions were done at pressure 1.5 ATA (atmosphere absolute) with 100% oxygen concentration, each lasting for 1–1.5 h either in multiplace chamber or monoplace chamber [13].