

Intensive rehabilitation combined with HBO₂ therapy in children with cerebral palsy: A controlled longitudinal study

Arun Mukherjee M.D.¹, Maxime Raison Ph.D.², Tarun Sahni M.D.³, Anand Arya MPT⁴, Jean Lambert Ph.D.⁵, Pierre Marois M.D.², Philip B. James M.B.⁶, Audrey Parent B.Sc.², Laurent Ballaz Ph.D.²

¹ Shubham Hospital, Kalkaji, New Delhi, India; ² Centre de Réadaptation Marie-Enfant, Centre Hospitalier Universitaire Sainte-Justine, Montreal, Quebec, Canada; ³ Indraprastha Apollo Hospital, New Delhi, India;

⁴ UDAAN for the Disabled Project of FSMHP C-27 Dayanand Colony, Lajpatnagar, New Delhi, India;

⁵ Department of Social and Preventive Medicine, School of Medicine, Université de Montréal, Montreal, Quebec, Canada; ⁶ Professor Emeritus, University of Dundee, Nethergate, Dundee, Scotland

CORRESPONDING AUTHOR: Laurent Ballaz Ph.D. – laurent.ballaz@uqam.ca

ABSTRACT

Objective: The present study aimed to assess the effect of intensive rehabilitation combined with hyperbaric oxygen (HBO₂) therapy on gross motor function in children with cerebral palsy (CP).

Methods: We carried out an open, observational, platform-independent study in 150 children with cerebral palsy with follow-up over eight months to compare the effects of standard intensive rehabilitation only (control group $n = 20$) to standard intensive rehabilitation combined with one of three different hyperbaric treatments. The three hyperbaric treatments used were:

- air (FiO₂ = 21%) pressurized to 1.3 atmospheres absolute/atm abs ($n = 40$);
- 100% oxygen pressurized at 1.5 atm abs ($n = 32$); and
- 100% oxygen, pressurized at 1.75 atm abs ($n = 58$).

Each subject assigned to a hyperbaric arm was treated one hour per day, six days per week during seven weeks (40 sessions). Gross motor function measure (GMFM) was evaluated before the treatments and at two, four, six and eight months after beginning the treatments.

Results: All four groups showed improvements over the course of the treatments in the follow-up evaluations ($p < 0.001$). However, GMFM improvement in the three hyperbaric groups was significantly superior to the GMFM improvement in the control group ($p < 0.001$). There was no significant difference between the three hyperbaric groups.

Conclusion: The eight-month-long benefits we have observed with combined treatments vs. rehabilitation can only have been due to a beneficial effect of hyperbaric treatment.

INTRODUCTION

Cerebral palsy (CP) is due to a lesion of the developing brain, characterized by inadequate muscle tone and control, often associated with other types of neurodevelopmental delay involving cognitive, communication and psychosocial skills. Treatments are mainly focused on exploiting residual cerebral function, and intensive rehabilitation is recognized to have demonstrated its efficacy in achieving better function and autonomy, thus creating a better quality of life [1].

The leading causes for cerebral palsy stem from a critical reduction of oxygen (O₂) delivery to a part of the developing brain in the perinatal period [2]. The site of the brain lesion can be localized with cerebral blood

flow measurements using brain single-photon emission computerized tomography (SPECT) [3,4] because impaired brain cell nutrition and oxygen delivery are related to inadequate blood flow. While hypoxia may cause neuronal death, there is a well-known phenomenon called the “ischemic penumbra,” which defines a volume of tissue surrounding a zone of infarction where cells receive enough oxygen to survive in an “idling state,” but not enough to function normally [5]. It has been suggested that these neurons might be viable much longer than previously believed [6,7,8], and this is where regenerative medicine is trying to play a role. Hyperbaric oxygen (HBO₂) treatment has shown reproducible benefits for more than two decades in hundreds of