Application of hyperbaric oxygen therapy as a primary treatment in cases of clinically significant macular edema in diabetic patients

Thesis Submitted for Partial Fulfillment of the MS Degree in Ophthalmology

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Contents

List of abbreviations

BCVA	Best Corrected Visual Acuity
CFZ	Capillary-Free Zone
CME	Cystoid Macular Edema
CNS	Central Nervous System
CRA	Central retinal artery
CSME	Clinically Significant Macular Edema
DME	Diabetic Macular Edema
DR	Diabetic Retinopathy
DRCRNET	Diabetic Retinopathy Clinical Research Network
ELM	External Limiting Membrane
ETDRS	Early Treatment Diabetic Research Study
FAZ	Foveal Avascular Zone
HBO	Hyperbaric Oxygen
HBOT	Hyperbaric Oxygen Therapy
ILM	Inner Limiting Membrane
IVit	Intravitreal
IVTA	Intravitreal Triamcinolone Acetonide
kPa	Kilo Pascal
LDL	Low Density Lipoproteins
MMG	Mild Macular Grid
NPDR	Non-proliferative Diabetic Retinopathy
OCT	Optical Coherence Tomography
ONH	Optic Nerve Head
ONL	Outer Nuclear Layer
OPL	Outer Plexiform Layer
PaO2	Arterial Blood Oxygen
PDR	Proliferative Diabetic Retinopathy
RCT	Randomized Controlled Clinical Trial
RPE	Retinal Pigmented Epithelium
UHMS	The Undersea and Hyperbaric Medicine Society
VEGF	Vascular Endothelial Growth Factor

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Introduction

Introduction

Hyperbaric oxygen therapy (HBOT) is a therapeutic method using high concentrated oxygen at higher pressure than normal atmospheric pressure, in order to increase PaO2 that has a beneficial biochemical, cellular, and physiological effects ***(Kindwall and Whelan, 2004)***.

HBOT can be used generally in ischemic diseases to increase oxygen supply to ischemic tissue, and in inflammatory diseases as the high oxygen perfusion can increase the healing process. ***(Davis and Bove, 2003)***

In Ophthalmology, Hyperbaric oxygen (HBO) is indicated in all ischemic diseases such as occlusive vasculopathies (central retinal artery occlusion, branch retinal artery occlusion), macular edema due to blood-retinal barrier breakdown in patients with diabetic retinopathy, cystoid macular edema (CME) of vascular origin (central retinal vein occlusion, branch retinal vein occlusion, retinitis pigmentosa), scleral necrosis of avascular origin (scleral thinning after pterygium surgery), orbital infections of mycotic and anaerobic origin (rhino-orbito-cerebral mucormycosis), nonhealing corneal

edema, anterior segment ischemia, proliferative vitreoretinopathy due to sickle cell disease, primary open-angle glaucoma, visual field defect after macular hole surgery, macular detachment, optic neuropathies of vascular origin. ***(Oguz and Sobaci, 2008)***

Diabetic retinopathy is an ischemic condition of the retina that occurs with chronic patients of diabetes mellitus. Diabetic retinopathy is subdivided into non-proliferative (NPDR) and proliferative (PDR) forms with or without macular edema occurring at any stage.

Macular edema is a common cause of visual loss in diabetic retinopathy, clinically significant macular edema (CSME) was defined as retinal thickening at or within 500 μm from the center of the macula, hard exudates at or within 500 μm from the center of the macula or if associated with thickening of the adjacent retina or a zone of retinal thickening larger than one disc area located within one disc diameter from the center of the macula identified on clinical examination. ***(Martidis et al., 2002)***

Various treatment modalities for diabetic macular edema were established including focal or grid argon laser photocoagulation, pars plana vitrectomy with and without peeling of the inner limiting membrane (ILM), intravitreal injections using triamcinolone acetonide or anti vascular endothelial growth factor (VEGF) ***(Meyer, 2007)***, and recently HBO. ***(Oguz and Sobaci, 2008)***

Anatomy of the macular area

Anatomy of the macular area

I. Gross Anatomy of the retina

- **The Retina**

Retina or nervous coat of the eye is a delicate diaphanous tissue that varies in thickness; 0.13mm at the umbo, 0.56mm at the foveal margin and adjacent to the optic nerve head (ONH), 0.1mm at the ora and 0.2mm at equator ***(Gass, 1997).***

- **The Human Macula**

At the center of the posterior part of the retina is an oval, yellowish area, the macula lutea, which is the retinal area for the most distinct vision. It has a central depression, the fovea centralis ***(Fig.1) (Snell and Lemp, 1998).***

Anatomically the macula (macula lutea or central retina) is defined as that portion of the posterior retina that contains xanthophyll and two or more layers of ganglion cells. It measures approximately 5.5mm in diameter and is centered approximately 4mm temporal to and 0.8mm inferior to the center of the optic disc ***(Fig.1).*** It corresponds to approximately 15 degree of the visual field ***(Gass, 1997).***