The Effect of Alcohol on Retina Function from Fetus to Young Adult Rats Who Exposed to Ethanol Prenatally

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It has been proven that drinking alcohol can lead to severe morbidity and mortality in cases of consumption and abuse by minors. In the case of alcohol abuse a mother there is a possibility of occurrence of disease in the child (Stromland and Pinazo-Duran, 2002). This dysmorphic condition was named as Fetal Alcohol Syndrome (FAS) (Stromland and Pinazo-Duran, 2002). Such a state is associated with a prenatal or postnatal deficiency in growth, an undistinguished mutation in the central nervous system and abnormalities in the craniofacial area (Stromland and Pinazo-Duran, 2002). It was shown that many different teratogens could cause similar malformations. Nonetheless, the majority of cases are associated with FAS (Stromland and Pinazo-Duran, 2002).

The human eye is sensitive to the teratogens as demonstrated in the research that was performed on both humans and animals (Stromland and Pinazo-Duran, 2002). The effect of alcohol on the human eye can be investigated through an age-appropriate ophthalmologic examination. It was estimated that both minor and significant anomalies are easy to identify by direct inspection. Furthermore, signs and symptoms of the teratogenic effect on the eye can be investigated by the usage of clinically assessable methodology as the estimation of visual acuity or ophthalmoscopy which can be applied to find retinal fundus pathology (Stromland and Pinazo-Duran, 2002). Therefore, to examine the effect of alcohol on the human organism, there is a need to analyze its impact on the eye. For that reason, this research aims to study the influence of alcohol on the retina using information from several animal models and clinical trials.

Alcohol Metabolism

It is essential to investigate the alcohol metabolism to estimate the animal and human models and suggest whether they are significant contributions to the understanding of the influence of alcohol abuse on the fetus during pregnancy and on children during their first years of life. First of all, it is important to mention that alcohol metabolism is a complicated process that has its variation in every living being. It was estimated that the neurochemical mechanisms and alcohol metabolism both contribute to the overall effect that alcohol has on the organism (Stromland and Pinazo-Duran, 2002). Therefore, not only the amount of alcohol is responsible for the consequences but also individual characteristics that shape the body’s susceptibility to alcohol. Second, genetics is another critical factor in this effect. It was shown that HOX and PAX genes could work as signaling molecules or transcription aspects that are regulating the growth of retina in humans and other animals (Stromland and Pinazo-Duran, 2002). The number of copies of these genes is estimated to control the adverse effect of alcohol (Stromland and Pinazo-Duran, 2002). Nonetheless, if they are all regulating the alcohol levels, there are no genes that can potentially induce the growth of the retina.

Investigating the effect of alcohol on the cell itself is essential. It was shown that alcohol intoxication includes a process that is called oxidative stress (Stromland and Pinazo-Duran, 2002). During this process, there is an intensive generation of disabling free radicals and a disorder of antioxidant protection in the cell. This process is ubiquitous in case of rats and an adult eye. Alcohol causes severe degradation by breaking cell membranes and interacting with several receptors, contributing to further changes in the morphology and purpose of proteins that control signal transduction, cell differentiation, gene expression, and proliferation (Stromland and Pinazo-Duran, 2002). These changes can be the cause of eye abnormalities. The variations in the physical properties of biological membranes can be lethal to cells (Stromland and Pinazo-Duran, 2002).

Moreover, the malfunction of appropriate adaptation mechanisms is contributing to the alteration of the cell (Stromland and Pinazo-Duran, 2002). These effects are inevitably causing axon degradation or dysfunction in the retina of the eye. It was shown in the last century that RNA synthesis and the density of the transcripts were limited in the ethanol-exposed eye tissues (Stromland and Pinazo-Duran, 2002). Therefore, the processes in the cell that is under the acute or chronic effect of alcohol toxicity are limited and are similar to those that are in cells that are under apoptosis.

Animal study Alcohol effect on retina

Narrative explanation and data

Table 1-1: Effect of Alcohol on retina animal model

Researchers Animal model and diet Types of Measurment Findings

Kennedy and Elliot (1986) A mouse animal model with a single administration of ethanol plus [3H]thymidine to the dam on day 13 of gestation. Mitotic and pyknotic cells were recorded and the width and depth of the eye and the neuroblastic layer thickness were measured 24 and 48 h after administration. The results revealed that ethanol altered the normal patterns of recruitment and loss of neural progenitors (stem cells)

This strongly suggests that an acute ethanol dose, administrated at a period when the neuroblasts display a high activity, may profoudly damage neuroretinogenesis and optic nerve development.

Harries et al. (2000) A rat animal model perinatally exposed to a high dose of ethanol. Nervous examination. A significantly reduced retinal thickness and layering and a specific loss of ganglion cells in ethanol-exposed animals, but not in controls.

Alcohol toxicity is targeting retinal nervous tissue. As a result of alcohol toxicity there are defects in the cytoarchitecture of the retina in axonal targeting and transmission of impulses.

(Katz & Fox, 1991)

Adult female Long-Evans hooded rats separated in groups

1. contols (N=11);

2. pair-fed controls (N=4);

3. prenatal only exposure to ethanol or human second-trimester equivalency (N=10);

4. prenatal plus an additional ten days of postnatal ethanol exposure or human third-trimestr equivalency (N=7).

ERG, Rhodopsin Measurments, and Blood Alcohol Determination. ERG estimated increases in absolute threshold and latency and decreases in response amplitude, decreases in the scotopic and photopic critical flicker-fusion frequencies, increment treshold functions, and absolute and relative refractory periods, rhodopsin content per eye was decreased in 3rd and 4th group.

These data showed that prenatal ethanol exposure produces long-term deficits in retinal sensitivity, amplitude, light and dark adaptation, temporal processing, and excitability.

Human study Alcohol effect on retina

Narrative explanation and then data in the table

Table 1-2: Effect of DHA interventions on retina in human

Reference Subjects Follow-up period Outcome Measurements Results

(Flangian et al., 2008)

Group 1: offsprings of heavy drinking mothers (N=101)

Group 2: offsprings of non-drinking mothers (N=101)

11 years Age appropriate ophthalmologic examination No significant differences in all of the outcome measurements

It was estimated by the authors that the low incidence of retinal abnormalities was caused by the subject evaluation process. The estimated high rates of retinal abnormalities were found among children that were evaluated as FAS. Most of the children in both groups cannot be evaluated as FAS, thus, have no significant abnormalities that are being estimated in FAS children.

(Strömland, 1987)

Children diagnosed with FAS (N=22)

Controls (N=22)

No data Age appropriate ophthalmologic examination Most children with FAS exhibit ocular abnormalities, including optic nerve hypoplasia (48%) and retinal vessel tortuosity (49%)

These rates are stating that animal models are eligible. Nonetheless, these results could be elevated as all of the children were referred for visual problems and not taken from an overall sample in the area.

(Ribeiro et al., 2007)

Children with FAS (N=32)

Control Children (N=25)

No data Age appropriate ophthalmologic examination Retinal vessel tortuosity in 30% and optic nerve hypoplasia in 25% of the children with FAS

The lower rates reported in this study could be caused by the bias that investigated in the previous research. Moreover, the authors suggest that several socio-economic or genetic causes could cause influence.

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