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Study of Muller Cells of Retina in Mice and Human Subjects suffering from Night Blindness using Electroretinography

KEYWORDS: Night blindness, Retina, Muller cells, Mice, Human.

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ABSTRACT *Aim: Night blindness or nyctalopia is diseases of visual system which is accompanied by night vision problem. It is reported that different retinal layers of these patients are deteriorated. The aim of present work is to look for the status of Muller cells of retina in human & mice population suffering from night blindness.*

Method: Forty mice were taken for the purpose of present work, 20 mice with normal retina as control and 20 mice with night blindness as case groups. Same number of human subjects were taken into consideration i.e. 20 human subjects with normal retina & 20 night blind patients. Electroretinography (ERG), was recorded in total animal and human subjects. Amplitude (μv) & latency (msec) was measured in total population i.e. animal and human subjects. Mean & standard deviation was calculated in control groups & according to the results, number of abnormal ERG, b wave in case groups were estimated.

Results: Seventeen mice and thirteen human in case groups had abnormal ERG b waves.

Conclusion: It is a well known fact that ERG b wave originates from Muller & bipolar cells in retina, therefore the abnormal ERG b wave in case groups is an indication of malfunctioning of Muller cells in night blind mice & human subjects which will be discussed in brief in full paper.

Introduction

Night blindness or nyctalopia is the inability to see well at night or in poor light. Night blindness is due to disorder of the cells in the retina that are responsible for vision in dim light. It has many causes such as Nearsightedness, Glaucoma, Glaucoma medications that work by constricting the pupil, cataracts, Diabetes, Retinitis Pigmentosa, Vitamin A deficiency and keratoconus [1, 2].

World Health organization (WHO) regional estimates indicate that the highest proportion of preschool-age children affected by night blindness, 2% is in Africa, a value that is four times of that estimated in south-East Asia (o.5%), that also means that Africa has the greatest number of preschool-age children affected with night blindness (2.55 million) and corresponds to almost half of the children affected globally. A comparable and high proportion of pregnant women affected by night blindness are in Africa (9.8%) and south- East Asia (9.9%), each of which is estimated to have over 3 million pregnant women affected or one third of the pregnant women affected globally [3].

A type of night blindness i.e. congenital stationary night blindness (CSNB) is an ophthalmologic disorder in horses with leopard spotting patterns such as the Appaloosa. It is present at birth (congenital), not sex linked, non progressive and affects the animal's vision in condition of low lighting. CSNB is usually diagnosed based on the owner's observations, but some horses have visibly abnormal eyes: poorly aligned eyes (dorsomedical strabismus) or involuntary eye movement (nystagmus). In horses, CSNB has been linked with the leopard complex color pattern since the 1970s. A 2008 study theorizes that both CSNB and leopard complex spotting patterns are linked to the TRPM 1 gene. The region on horse chromosome 1 to which the Lp gene has now been localized also encodes a protein that channels calcium ions, a key factor in the transmission of nerve impulses. This protein found in the retina and the skin, exists in fractional percentages of normal levels found in the retina and the skin, exists in fractional percentages of the normal levels found in homozygous LP/LP horses and so compromises the basic chemical reaction for nerve impulse transmission [4-6].

Retina is a part of visual system that can be damaged due to night blindness. There are different techniques that can evaluate the retinal status of visual system. Electrophysiological examinations are among these techniques. Electroretinography (ERG) and Electrooculography (EOG) are two electrophysiological techniques that measure the electrical responses of various retinal layers [7].

Electrooculography is a technique for measuring the corneal-retinal standing potential that exists between the front and the back of the human eye. Primary applications are in ophthalmological diagnosis and in recording eye movements [8]. Electroretinography (ERG) measuring the electrical responses of various cell types in the retina, including the photoreceptors (rods and cones), inner retinal cells (bipolar and amacrine cells), and the ganglion cells. The ERG is composed of electrical potentials contributed by different cell types within the retina, and the stimulus condition can elicit stronger response from certain components.

If a dim flash ERG is performed on a dark adapted eye the response is primarily from the rod system. Flash ERG performed on light adapted eye will reflect the activity of the cone system. Sufficiently bright flashes will elicit ERG, containing an a-wave (initial negative deflection). The leading edge of the a-wave is produced by the photoreceptor, while the reminder of the wave is produced by a mixture of cells including photoreceptors, bipolar, amacrine, and Muller cells or Muller glia. The pattern ERG, evoked by an alternating checker-board stimulus, primarily reflects activity of retinal ganglion cell [9-10].

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In the present work night blind mice were undergone ERG examination and their Muller cells were taken into consideration for possible degeneration due to night blindness. The same procedure was done on human night blind patients. The results obtained in two groups were compared together.

Material and Method

In a cross- sectional analytical study 40 mice were taken for the purpose of present research work. Twenty of mice were undergone certain procedure to suffer them from night blindness. To check the night blindness status of the mice population, dim flash ERG with dark adaptation was examined on the eyes of the night blind mice. These mice were taken as a case group. Along with these mice population, 20 remaining mice were taken as a control group.

In next step 20 human subjects with crohn's, celiac, cystic fibrosis diseases with night blindness due to problems in absorbing nutrients from gastrointestinal tract were selected as a second case group in human population. Along with human case group 20 human subjects with healthy visual system mainly retina were selected as a human control group.

Flash ERG was recorded in total 80 animal and human subjects. Metro vision was used for animal subjects & Biomedical Mangoni was the instrument used to record flash ERG in human subjects. Conventional electrode attachment was used in both animal & human groups. Voltage (μv) and latency (msec) of b wave of ERG measured for each subjects. Mean & standard deviation were calculated for each group. SPSS-version 13 was used to compare the results obtained in total groups.

Results

ERG, b wave, amplitude (μv) and latency (msec) were measured in equal number of human & mice groups, i.e. Case and control. The mean amplitude ±SD in mice and human control groups were &82.15 ± 9.91 and 108 ± 11.32 respectively and the mean latency ± SD in mice and animal groups were 41.2 ± 3.1and 43 ± 2.50 respectively. Base on these results, 17 mice & 13 human subjects in case groups had abnormal ERG, b wave either in amplitude (reduction) or latency (delay) respectively.

Discussion

The results of present work can be classified into two parts. First part in animal subjects i.e. mice were taken into consideration and b wave of ERG was measured in control group of mice with healthy retina and case group with abnormal retina i.e. night blindness. Beside the animal group, same numbers of human population were taken into consideration and same procedure was repeated for this group also. The results in two groups were compared together.

According to the results obtained 17 mice in case group had abnormal ERG, b wave either reduce amplitude or broad b wave. It is a well known fact that b wave of ERG originate from Muller & bipolar cells in retina [10]. Therefore abnormal ERG b wave is an indication of degeneration in these two cells, i.e. bipolar & Muller cells.

Considering human population again the same trend is observed and the only difference is lesser number of human in case group i.e. night blindness patients shows abnormal ERG b wave, (13 out of 20).

The difference between animal and human population as far as case group is concerned may be due to variety of night blindness patients in human subjects which was inevitable, i.e. some of the patients were treated for vitamin A deficiency two three times before the new incidence [11].

There are quite large references in this connection; in this relation we will bring two related works as follow,

Pardue MT et al performed a research on mouse model of x-linked congenital stationary night blindness and they found abnormal ERG b wave pattern which supports the results of present work [12].

It is to mention the fact that there are lot of research works in this connection & it is interesting that there are number of contradictory results. Chia A et al worked on large number of patients suffering from night blindness & they came to conclusion that large number of these subjects had normal ERG [13]. This work is in contradiction with the results of present work.

Conclusion

From the results of present work one can conclude that ERG technique particularly the b wave is a suitable parameter to search for retinal changes mostly bipolar and Muller cells in human and animal subjects suffering from night blindness.

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