Electroretinography thesis example

Environment, Disaster

Introduction

Electrophysiology is the study of the electrical nature of biological cells and tissues. It is the basis of several ophthalmological techniques that can provide information about the retinal function. Three distinct electrical potentials have been identified in retina viz. Early receptor potential (ERP), electroretinogram (ERG), and electrooculogram (EOG). ERP is generated by the photopigment molecules in the outer part of visual receptors. ERG extends from pigment epithelium to the inner nuclear layer. EOG is a function of pigment epithelium but also depends on outer and inner layers of the retina.

ERG arises in the retina after light stimulation and is detectable all around the eye. The light stimuli may either be a pattern (spatially structured) or flash (unstructured) and the retina may be partially or fully stimulated. However, the electrical potential is largest at the center of the cornea. It results from the composite activity of millions of retinal cells. Since all the cells in the inner and outer nuclear layer of the retina contribute to ERG, it can be used as a function of these cells. The size and the shape of ERG depend upon the amount of light reaching the retina. If the retina is strongly illuminated, the ERG is large & quick and vice versa. The rods and cones contribute their signals to the ERG in an independent way. One can separate the responses from the rods and cones in human ERG by the differences in their wavelength sensitivity and behavior to light adaptation and flicker (Gauras, 1970).

The ERG consists of a negative deflection (a-wave) and a positive deflection (b-wave). A-wave is due to the response of photoreceptors and is generally

not recordable in rod ERG responses in case of low intensity flashes. B-wave is associated with on-bipolar cell function and is recorded in lower intensity flashes that do not produce the a-wave response. ERG is utilized in the detection of hereditary retinal disorders including retinitis pigmentosa, pigmentary retinopathies, cone dystrophies, juvenile X-linked retinoschisis, congenital stationary night blindness, macular disorders, etc. Though ERG is an important clinical tool, it has limited use in evaluation of abnormalities involving very small areas of the retina such as fovea. The limitation is due to the fact that large areas of retina must be illuminated in order to produce a detectable ERG response (Gundogan, Tas & Sobaci, 2011).

Full-field ERG is the diffuse response of both neural and non-neural retinal cells to a light stimulus. This response is the sum of both the positive and negative components originating from different stages of retinal processing. The electrical activity in the ERG results from light-induced changes in the trans-retinal movements of sodium and potassium ions in the extracellular space. The electrical retinal responses are recorded by active electrodes that contact the cornea and bulbar conjunctiva. These electrodes may be of several types such as contact lens electrodes, conductive fibers and foils, conjunctival loop electrodes, corneal wicks, etc. (Gundogan, Tas & Sobaci, 2011).

There are several specialized types of ERGs that provide additional information about retinal function. These include macular/focal EFG, pattern ERG, multifocal ERG, direct-current ERG, bright flash and double flash ERG, etc. (Marmor, Holder, Seeliger & Yamamoto, 2004). Pattern electroretinogram (PERG) is a specific type of ERG that represents retinal

response induced by contrast reversing pattern. It aids in the functional assessment of retinal ganglion cells and finds use in the investigation of anterior visual pathway disease. It provides valuable information about macular functions; however, it lacks the topographical information of the retinal response. The conditions like optic neuritis, glaucoma and optic atrophy have reduced or completely absent PERGs in the presence of intact ERGs (Holder, 1987). Multi-focal electroretinography (mfERG) is another technique for the analysis of local retinal function. It enables topographic mapping of retinal function in the central 40-50 degrees of the retina (Gundogan, Tas & Sobaci, 2011).

One of the most important techniques that measure the electrical potential of the retina in response to full flash stimuli is flash electroretinography (FERG). Rapid changes in the retinal electrical potential take place after the stimulation with a uniform light flash. These changes lead to the generation of a flash electroretinogram. The formation of the waves during the records results from the outer retinal layers and these records are indicative of the functional condition of retinal layers. By controlling the stimulus' frequency, the FERG responses can be categorized into transient response at low frequency stimulation and steady state response at high stimulation rate. In the steady state response resulting from the overlapping of the transient ERG responses, the important temporal information is lost.

The present study aimed at extracting the per-stimulus transient response evoked by the retina in response to high-stimulation rate stimuli in order to be able to analyze the temporal component of the FERG accurately in real time. Anatomy and physiology of the visual system have been discussed in

the beginning (chapter 2) of the thesis so as to make the process of the vision clear. The electrophysiology of the vision is also discussed along with the different types of electroretinographies. Chapter 3 of the thesis presents the methods used in the study. It focuses the instrumentation, recording and processing of the data. The results and discussion of the study have been summarized in chapters 4 and 5 respectively. In this study, two different mathematical theories were used to validate the results and compare their ability to provide consistent and dependable results. Overall, this study will provide more reliable information for understanding the sources of retinal malfunctioning.

References

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