The electrooculogram: A refinement of the method

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Abstract. The measurement of the light rise of the corneoretinal potential in the clinical routine depends critically on the constancy of the eye movements made by the subject. To verify to what extent the variability of the Arden ratio can be explained by the variability of these eye movements, an infrared scleral reflection technique was applied in order to monitor eye position and electrooculogram simultaneously. The data obtained in 10 normal subjects show that not only is the variability reduced substantially by correction for the actual eye movement, but also the routine procedure gives a systematic underestimation of the ratio. Monitoring eye movements makes available the use of eye movements of arbitrary size (e.g., optokinetic nystagmus), allowing for application of the method in uncooperative subjects such as children.

Introduction

The electrooculogram (EOG) is the registration of the corneoretinal potential, which varies following a change in illumination of the eye. This slowly varying potential finds its origin in the retinal pigment epithelium (RPE) [1] and is highly correlated with its metabolic activity. The quantification of its rise upon illumination of the retina has proven a valuable test as to the functioning of the RPE [2].

The determination of this light rise is based on the recording of the potential step between two electrodes positioned left and right of the eye, while the subject makes eye movements of a predefined size, e.g. by switching fixation between two light spots. Subsequent recordings in the dark and the light with otherwise equal conditions provide an estimate of the light peak/dark trough ratio, the so-called Arden ratio [2].

The variability of the Arden ratio is high [3, 4, 5], which limits the clinical applicability to those pathologies that show relatively large reductions of the light rise. From the above description of the procedure it can be readily concluded that the accuracy of the determination a.o. is highly dependent on the ability of subjects to make well defined eye movements. To verify this
assumption an infrared scleral reflection technique is applied to monitor eye position during the recording of the electrooculogram. In this way the eye movements are measured directly and the EOG can be corrected for the actual size of the eye movements made. The present paper exemplifies that a significant part of the variability of the light peak/dark trough ratio can be attributed to the variability of the eye movements.

**Subjects**

Ten volunteer subjects with normal vision were measured in this study (ages 20 to 58 yrs). Only right eye data are presented.

**Methods**

The electrooculogram was recorded from AgAgCl electrodes positioned near the lateral and medial canthus of the eye (A = 10000, TC = 2 s, HF = 75 Hz). Simultaneously eye position was recorded with an infrared scleral reflection method (IRIS: accuracy 1’, 3% linearity up to 35° eccentricity [6]). The system was mounted in a spectacle frame attached to the head by means of a helmet made of velcro tape, which could be easily adjusted to the physical dimensions of the subject’s head. Both the EOG and the eye position signals were sampled every 20 ms (Apple computer [7]) during a 10-second period in which the subject was fixating two alternating light-emitting diodes at approximately 10 degrees apart. This procedure was repeated every two minutes during a 10-minute dark adaptation period and a 15-minute light adaptation period. Dark adaptation occurred in complete darkness except for the two alternating LEDs that served as fixation marks. During the light phase the room lights were switched on and the subject watched a square homogeneous field of 40 degrees visual angle at 300 Lux.

The ratio of EOG amplitude over IRIS amplitude was calculated for every eye movement and normalized in the final plot to the maximal value (100% at the light peak).

**Results**

The amplitudes of the saccadic eye movements measured in the EOG are plotted in Fig. 1 as a function of the time instant in the recording session of