Recording the Pattern Electroretinogram: A Cautionary Note

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It is possible to record a pattern electroretinogram (PERG) of near normal amplitude in a situation when the eye containing the active electrode is occluded. Because PERG recording requires high amplification and sensitive signal retrieval techniques, the electrode in the occluded eye records a distant potential from the unoccluded eye. Referencing the active electrode to an ipsilateral ear diminishes, but does not eliminate the referred PERG potential. Such unlooked for interaction may provide misleading data in situations where binocular viewing is used because of poor vision in one eye; therefore, occlusion of the eye not being tested should be undertaken whenever possible. Invest Ophthalmol Vis Sci 24:796–798, 1983

While exploring the parameters for optimally recording the pattern electroretinogram (PERG), we discovered that a large response could be obtained from the eye that did not contain the active recording electrode. It is the purpose of this report to set forth the circumstances that give rise to the appearance of this unexpected response and also, because it is unwanted, the precautions that may be taken to minimize its occurrence.

Materials and Methods. Three young adults with normal vision were used as subjects. All had 20/20 vision in each eye. An electronically generated, counterphase reversal checkerboard (11 pattern alternations/sec) was displayed on a Conrac Video monitor (mean luminance 50 cd/m²). We have described our stimulus in terms of alternations/sec in order to avoid confusion that may be caused by the term “Hz.” Our stimulus undergoes uniform global reversals of a repeating pattern. Here, reversals and rereversals are indistinguishable. The PERG and VER, being mass nonspike responses, are identical to each alternation. The fundamental period of both the stimulation and response, then, is the time between alternations and this period has been used for all phase calculations. At a distance of 71 cm the screen subtended 16 X 22° of visual arc and the checks were 1°/side. The check contrast was always maintained at 50%. A gold foil electrode was hooked over the lower lid of the left eye. A pair of gold-plated earclip electrodes served as the reference and ground leads. Initial stage of amplification was provided by a Grass P9A; gain setting = 5K, band pass (6 db attenuation) set at 3 and 30 Hz. A trial consisted of 128 sweeps of 300 msec each summed on a Nicolet 1120/334B signal averager.

One patient who for a period of 2 yrs had a unilateral meningioma impinging upon the left optic nerve was also tested. This 33-year-old woman was examined after surgery at a time when vision in her left eye consisted of only “light perception” in the superior quadrant. Ophthalmoscopically, the left eye showed a pale yellow disc and almost no sign of the nerve fiber layer reflex visible on red free light examination. Her right eye had normal (20/20) acuity, full visual field, and a normal appearing fundus.

Results. The basic findings on normal subjects are shown in Figure 1. A gold foil electrode was placed in the left eye for all the recordings in the Figure, while the contralateral (right) ear was used as a reference. The top tracing (Fig. 1A) represents the binocular viewing condition. Three PERG waveforms are evoked in response to an alternation rate of 11/sec. Their average amplitude is 2.6 µV. When the left eye is occluded (Fig. 1B), a 27% smaller (1.9 µV) and clearly detectable series of PERG waveforms is recorded. To test whether the latter waves originated from some instrumental artifact both eyes were occluded (IC). No electrical signal appeared in response to the visual pattern which, of course, is not seen by the subjects.

In the binocular viewing conditions we found that placing the reference electrode on the left (ipsilateral) ear instead of the right resulted in a 55% reduction, but not a complete elimination, of the amplitude of the referred PERG.

We wondered whether recordings obtained when the left eye was occluded might simply be a visually evoked cortical response (VER) conducted to the eye-ear electrode configuration. Accordingly, we repeated the condition shown in Figure 1B while simultaneously recording the VER using a scalp electrode 1.5 cm above the inion and referenced to the right ear. Using a slow (1.5 alternations/sec) reversal rate to elicit only a single transient response per sweep, the PERG showed a latency of 41 msec, whereas the latency of the first positive VER wave was 99.8 msec (Fig. 2). At the faster reversal rate of 11 alternations/sec (90.9 msec period between alternations) this latency difference translates to a 127° phase shift of the potentials. This indeed is close to the observed phase difference when comparing simultaneously recorded steady state PERG and VER using a reversal rate of 11 alternations/sec.

Figure 3 presents the results obtained from the patient with unilateral optic nerve neuropathy. It is clear that referred PERGs can be recorded from the affected eye using either binocular viewing (2.4 µV, Fig. 3A) or allowing only the normal eye to view the
Figs. 1A–C. A, PERG recorded under binocular viewing conditions with the electrode located as shown. One degree checks at 50% contrast; reversal rate = 11/sec. B, PERG recorded under monocular (right eye) viewing with the active electrode placed in the occluded left eye. C, Control recording obtained when both eyes were occluded.

Discussion. We have demonstrated that under certain conditions of stimulation and electrode placement a referred PERG of large amplitude can be recorded when the affected eye was tested correctly, i.e., when her normal eye was occluded and an active electrode was located only in her affected eye (Fig. 3B). During this condition, the patient maintained direction of gaze on the checkerboard pattern by touching the center of the television screen with a pointer and fixating in that spatial direction.

PERG

VER

Fig. 2. Simultaneous recording of the PERG and VER in response to 1° checks; contrast = 50%; alternation rate = 1.5/sec. Top tracing: PERG with a latency of 41 msec, Bottom tracing: VER P100 latency 99.8 msec. Note the reduction in PERG amplitude at this lower reversal rate.

Figs. 3A–C. PERGs recorded from a patient with unilateral meningioma impinging upon her left optic nerve; 1°/side checks; 75% contrast. A, Binocular viewing with the active electrode in the affected eye. B, Monocular viewing normal eye occluded. C, Monocular viewing by the normal eye; the affected eye containing the active electrode is occluded. Note the recording of referred PERGs in conditions A and C.

corded when the eye with the gold foil electrode is occluded. This referred potential is lessened in amplitude by using the ear ipsilateral to the eye being tested as the reference. Many workers use various locations on the forehead as a reference point for PERG work; we found that while the unwanted referred potential is smaller in amplitude using this configuration, it is likewise true that all recordings thus obtained are smaller in amplitude and electrically noisier compared to those using the ear lobe as a reference. Irrespective of the placement of the reference electrode, however, it is quite clear that whenever possible PERG recordings should be done monocularly (as shown in Fig. 3B).

Given the high quality of modern differential amplifiers and the superb retrieval capabilities of sophisticated averagers, these results are not particularly surprising. In a normal eye we were able, for example, to replace the active foil electrode with a disc electrode on the forehead and still record a recognizable PERG of small amplitude. What is surprising, however, is that workers (including ourselves) find greatly diminished PERG recordings using binocular viewing in many patients with unilateral optic neuropathies.2,3 With very poor vision in one eye, the practice is to use the more normally sighted eye as the fixing eye. The present findings would lead one to expect to record a PERG under such recording conditions. But this is not always the case, even though in the present report we have recorded a referred PERG in all normal subjects and in our patient with one normal and one pathologic eye. We have found that a combination of less than optimal stimulus conditions (i.e., slow reversal rates) and electrode configurations
(referencing the active electrode to the forehead where a small but recordable response is also present) combine to reduce the PERG amplitude. In such situations it is less likely that the spread of potential will be strong enough to be recorded as a referred response. On the other hand, if, in a binocular viewing situation, one records a normal PERG from an eye that has no light perception, the possibility that a referred PERG may have been recorded inadvertently must always be entertained.4

Key words: pattern electroretinogram, visual evoked response, optic neuropathy

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References


Comparison of Three Methods for Rapid Determination of Threshold Contrast Sensitivity

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Threshold contrast sensitivity functions for 13 subjects were determined on 5 consecutive days using three psychophysical methods. Each method was implemented on a microprocessor controlled display system and considered as a possible candidate for a rapid visual screening test. The methods used were Bekesy tracking, method of adjustment, and method of increasing contrast. The method of increasing contrast proved superior to the other methods in repeatability, speed, and the preservation of individual differences in contrast sensitivity over the testing period. Invest Ophthalmol Vis Sci 24:798-802, 1983

A growing body of data collected over the past 10 years attests to the importance of contrast sensitivity functions (CSFs) in assessing important aspects of visual performance of an individual. Ginsburg1 demonstrated that threshold detection and identification of letters of various sizes are directly related to a subjects' contrast sensitivity, not visual acuity. Owsley, Sekuler, and Boldt2 have also shown similar relationships with faces. Brain lesions,3 multiple sclerosis,4,5 and cataracts6 can cause visual abnormalities that are detected easily using threshold contrast sensitivity measurements. Many of these abnormalities are not detected by Snellen-type visual acuity measurements for reasons described by Ginsburg.1

We present in this paper three candidate methods for rapid assessment of CSF using an automated display device. Our goal was to minimize testing time while using a test that showed the greatest repeatability for each subject tested.

Contrast sensitivity at each spatial frequency was defined as the reciprocal of the threshold contrast. The same data analysis technique was used for all three methods tested. Individual contrast sensitivity functions for single sessions were determined for each of 13 subjects. Threshold contrast from n trials at each spatial frequency were converted to contrast sensitivity and the log mean of the contrast sensitivities was computed. The number of trials per session, n, was 5 for the method of increasing contrast and the method of adjustment and 16 for Bekesy tracking. These CSFs were then averaged across trials and sessions for each method, again using the log mean, to give one CSF per subject for each method. Finally, the log mean and standard deviation of the 13 CSFs comprising the data set for a given method were computed to produce a single representative CSF for each method.

Materials and Methods. A microcomputer controlled video display (Optronix Corp. Model 100) was used to generate sine-wave gratings. The display screen, having a mean luminance of 60 cd/m², sub-

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