I. Introduction

The electroretinogram (ERG) is the most informative and direct measure of retinal function available, yet is rarely used in its clinical application. Barriers to clinical application of ERG include lack of protocols that provide information about the peripheral retina, an area that is important for early diagnosis and monitoring of several diseases.

Currently available tests, e.g., optical coherence tomography (OCT), Humphrey Visual Field (HVF), and pattern ERG (pERG), target the central retina, leaving areas beyond this region underexplored.

Peripheral pattern ERG (ppERG) is a complementary test designed to target the peripheral retina. The test enables objective measurement of function and loss beyond 20 degrees of visual field.

Here, we describe pattern ERG responses elicited from the mid- and far-peripheral retina. Responses for healthy and glaucomatous eyes are compared.

Local pattern stimuli targeting anatomically motivated areas of the peripheral retina are demonstrated.

II. Methods

A 256-element checkerboard pattern was delivered to the peripheral retina to obtain responses to ring stimuli and sector stimuli. Two protocols were followed for pERG recording:

- **Ring stimuli** were viewed at a distance of 30 cm, field subtending 30°–10° (inner to outer edge), check size: 10°.
- **Sector stimuli** were viewed at a distance of 41 cm, field subtending 21°–60° (inner to outer edge), check size: 8°.

For all protocols, mean light exposure: 1070 photopic candela per square meter (ph cd m⁻²), reversal rate: 4.6 reversals per second (RPS).

ppERG response waveform analysis. Responses were recorded from eleven normally sighted subjects, and two glaucoma patients. A. Typical ppERG response waveform [50 Hz, passband 1-1000 Hz] exhibits high- and low-frequency components; these were isolated prior to evaluation of each response for amplitudes and latencies of each peak / trough. B. Isolated low frequency components (1-50 Hz). Amplitude of the late-positive component [P] was measured from baseline, amplitude of the late-negative component [N] was measured from P. C, Isolated high-frequency ppERG components. Black: passband 50-300 Hz, right amplitude axis) compared to the isolated oscillatory potentials [OPs, blue, passband 75-300 Hz, left amplitude axis) extracted from flash ERG responses obtained from three subjects. D. Comparing flash ERG [A], ppERG recommended protocol and ppERG responses from the same cohort in C.

ppERG responses were recorded from normal eyes over a flash intensity range of 1-50 Hz. Amplitudes of the early positive component [P] were measured from baseline, amplitude of the late negative component [N] was measured from P. E. Responses to ring stimuli recorded from the right eye of a mid-stage glaucoma patient (red). F. HVF responses (mean deviation: -0.07 dB, visual field hemi-field test [VHF]: outside normal limits) and pERG responses from the corresponding eye.

E. Response to ring stimulus from the same patient, compared to the healthy mean (n = 5). Each component amplitude elicited by pERG and pERG responses for a glaucoma suspect, compared to the healthy mean (n = 5), error bars (n = 1 standard deviation). Ratios of N amplitude (each sector response divided by the sum of the other two), evaluated to assess asymmetry in functional changes.

Below, same construction as at right, for a glaucoma suspect. Responses were recorded from the right eye. HVF 24-2 was normal (mean deviation: -1.00 dB). F. Result: normal.

Above: ppERG responses elicited from ring and sector stimuli. Responses were recorded from flu normally sighted subjects. A. Ring stimulus ppERG responses, low frequency components, plus mean waveform across subjects. Mean plots the pERG responses recorded from the same cohort. D. Isolated low frequency components elicited from peripheral retina in three defined field sectors.


III. Results

A. ppERG: Ring Stimuli

B. ppERG: Sector Stimuli: Superior-Nasal

C. ppERG: Sector Stimuli: Inferior-Nasal

D. ppERG: Sector Stimuli: Temporal

IV. Summary

A stimulus for targeting ganglion cell function in local sectors of the peripheral retina has been developed. The sector stimuli were defined by mapping peripheral visual field areas to circumpapillary OCT sectors via the RNFL fiber tracks.

ppERG responses to sector stimuli were robust and could be obtained at suitable SNR in a reasonable amount of time, though protocols are still being optimized.

Sector responses suggest promise in measuring asymmetric functional changes associated with early stage glaucoma.

ppERG may prove to be complementary to central retina tests, yielding superior sensitivity and specificity when strategically combined.

Commercial Relationships

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