Macular electroretinograms and contrast sensitivity as sensitive detectors of early maculopathy

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Abstract. Eighteen patients with early maculopathies of various etiologies were tested with pattern and focal electroretinograms (macular ERGs), with high (400 cd/M²) and moderate (40 cd/M²) stimulus intensities and a four-alternative forced choice (4AFC) contrast sensitivity test in addition to intensive clinical examinations.

High spatial frequency contrast sensitivity loss on the 4AFC test was the most striking and consistent feature of all cases. The only eyes not outside normal contrast sensitivity limits were three in which diagnosis was uncertain and the patients had not recognized any problem, including two marginal solar burns. Maculopathy also substantially reduced macular ERG amplitudes. Criterion scores on these tests separated patients from normals more effectively than other noninvasive procedures and only missed one eye detected by contrast sensitivity. Latencies were affected but the delays were of no clinical significance in the individual case. Stimulus intensity was not critical.

The results indicate that contrast sensitivity testing and macular ERGs are very reliable indices of central visual dysfunction at a stage when visible macular changes are too subtle for confident diagnosis. Contrast sensitivity has appeal because of its reliability, objectivity, simplicity, and noninvasive nature. It is equally applicable to children and adults. Pattern and focal ERGs can establish that the visual deficit has a retinal origin and can provide the most reliable objective confirmation.

Introduction

Two years ago in his opening address Dr. Lawwill (1984) reminded the International Society for Clinical Electrophysiology of Vision that a major clinical advantage of pattern and focal ERGs is that responses evoked by either stimulus are generated within a restricted retinal area. Localized damage will have a proportionately larger effect on pattern ERGs (PERGs) or focal ERGs (FERGs) than it would on the ganzfeld ERG. Clinical applications mostly involve the macula, where testing is easiest. Arden and Bankes (1966) introduced “foveal” ERGs some time ago, and Biersdorf and Diller (1969) used “local” ERGs (evoked by flashing a small red light in a brightly illuminated ganzfeld sphere) in a similar way.

The normality of ganzfeld flash ERGs in maculopathy is well known, but three recent reports have pointed out that macula-specific ERGs are substantially reduced in such cases (Jacobson et al., 1979; Sandberg et al., 1980;
Arden et al., 1984). Macular ERGs (such as local, foveal, focal, and pattern ERGs) appear to be the electrophysiological routine of choice in maculopathy regardless of the academic debate about their relationship to each other and to the conventional flash ERG (Spekreijse et al., 1973; Arden et al., 1980; Vaegan, 1981; Maffei and Fiorentini, 1981, 1982; Arden et al., 1982; Vaegan et al., 1982; Holden and Vaegan, 1983; Korth, 1983; Riemslag et al., 1985). We examined 18 cases of early maculopathy with PERGs and FERGs and compared the results with a simple printed contrast sensitivity test (Vaegan and Halliday, 1982) and other clinical tests of central visual function in order to determine precisely how sensitive the tests are. We routinely included two levels of stimulus intensity to see whether they influenced the sensitivity of the tests, for reasons discussed in a separate paper (Vaegan and Billson, in press). In this paper we describe the absolute losses relative to normals on the tests and the effect of intensity. Detailed analysis of the correlations between these and other clinical measures are to be reported elsewhere.

Materials and methods

Pattern and Focal ERGs were recorded by methods which have been previously described (Vaegan et al., 1984). Briefly, gold foil electrodes, which were produced locally (Vaegan, 1984) from our own gold-plated plastic were placed in each lower fornix. The references were silver-silver chloride electrodes (Red Dot, 3M Corporation) between the outer canthi and the outer orbital ridges. The ground was a similar electrode on the central forehead. The skin was cleaned with an alcohol swab and lightly rubbed with an abrasive, electroconductive gel (Omniprep, D.O. Weaver, Colorado) until impedance was below 3000 ohms. Responses from both eyes were recorded simultaneously, amplified by 50,000, and filtered between 2.5 and 100 Hz. Overflow artifacts were rejected and 256 sweeps were averaged by means of PDP11/23 computer. At least two FERGs and PERGs were recorded in ABBA order at each intensity and stored with the test parameters. The several records were later combined into a single average, and peak amplitudes and latencies were measured by means of other computer routines. The normal peak times and associated ranges of variability (Table 1) were used to select minima and maxima to measure in about 5% of the patients' traces where peaks were not apparent within the noise.

The stimulator was a rear projection system (Digitimer D112). The screen subtended 32 × 32 degrees at 57 cm. The fixation point was a central 2-cm translucent red dot. Intensity was inhomogeneous (600–200 Cd/M², measured from the patient's eye position with a Pritchard Spectra Photometer). Approximate mean maximal luminance (Lmax) was 400 Cd/M². A neutral filter in front of the pattern slide was also used to reduce stimulus intensity 1 log unit. The screen was surrounded by two large white cardboard sheets,