Visual Evoked Potential And Contrast Sensitivity Tests In Anisometropic Amblyopia

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Research Article

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Abstract

Background

Amblyopia is a disorder of sight in which the brain fails to process inputs from one eye and over time favors the other eye. Refractive amblyopia is caued by anisometropia (difference of a certain degree of myopia, hypermetropia, or astigmatism), or by significant amount of equal refractive error in both eyes. Visual Evoked Potential/Response (VEP/VER) measures the electrical signal generated at the visual cortex in response to visual stimulation. Contrast sensitivity (CS) is the ability of the eye to detect small changes in illumination at targets that do not have clearly defined limits

Objectives

To compare between the amblyopic eye and the fellow eye regarding the VEP and CS in patients with anisometropic amblyopia.

Methods

This is a cross sectional study carried out on 78 patients with anisometropic amblyopia aging 4.5–12 years. All patients presented with monocular amblyopia. Pattern visual evoked potentials and contrast sensitivity tests were carried out for both eyes.

Results

the amblyopic eye showed an increases in P 100 latency and decrease in amplitude compared to the fellow eye. Also the contrast sensitivity test showed decreased values of the amblyopic eye compared to the fellow eye.

Conclusion

VEP and CS tests could be used to assess the prognosis of patients with anisometropic amblyopia.

Introduction

Amblyopia is the one of the most common causes of decreased vision in a single eye among children and younger adults. By time the brain favours one eye over the other and neglects the signals from the amblyopic eye. The word amblyopia is from Greek amblys, meaning "blunt", and ops, meaning "sight" [1].

Amblyopia is characterized by several functional abnormalities in spatial vision, including reductions in visual acuity, contrast sensitivity function, and vernier acuity, as well as spatial distortion, abnormal spatial interactions, and impaired contour detection. In addition, individuals with amblyopia suffer from binocular abnormalities such as impaired stereoacuity (stereoscopic acuity), depth, perception and binocular summation [2].

Also, central vision in amblyopes is more crowded than central vision in normal observers. However, perception of depth, from monocular cues such as size, perspective, and motion parallax remains normal [3].

Refractive amblyopia is caued by anisometropia (difference of a certain degree of myopia, hypermetropia, or astigmatism), or by significant amount of equal refractive error in both eyes [4].

Visual Evoked Potential/Response (VEP/VER) measures the electrical signal generated at the visual cortex in response to visual stimulation. The visual cortex is primarily activated by the central visual field and there is a large representation of the macula in the occipital cortex. VEP depends on the integrity of the visual pathway including eye, optic nerve, optic chiasma, optic tract, optic radiation and cerebral cortex [5].

Contrast sensitivity (CS) is the ability of the eye to detect small changes in illumination at targets that do not have clearly defined limits. Measuring CS is just as important as VA and is now universally accepted as complementary as it reflects the quality of vision and in many cases declines earlier, while VA remains normal (6/6 or better) [6].

Subjects and methods

This cross sectional study was conducted on 78 patients with unilateral anisometropic amblyopia aging 4.5–12 years. Patients were recruited from the pediatric Ophthalmology clinic, Abo el rich hospital, Cairo University. Their parents gave a written consent to the study. The study was approved by Research Ethics Committee, Cairo University, Kasralainy hospital, with the code MD-224-2020.

Patients with any disease affecting the retina or the optic nerve as diabetes mellitus, retinitis pigmentosa, optic neuritis and vasulitis were excluded. Also, patients with implanted medical devices were excluded.

Methods:

Clinical and ophthalmological examination.

Visual acuity was measured and written in decimal notation by using the best refractive correction, done by a pediatric ophthalmology specialist.

Pattern visual evoked potentials

Electrode placement:

The recording active electrode were placed on Oz, the reference electrode was placed on Fz and the ground electrode commonly on Cz according to international 10–20 electrode placement system.

Stimulus:

The VEP stimuli were standard black (5 cd/m2) and white (80 cd/m2) pattern-reversal checkerboards generated with a Roland Consult clinical electrophysiology system viewed from 100 cm with a temporal frequency of 2 Hz. The stimuli were presented with a resolution of 1280 × 1024 at two contrasts (100% and 50% contrast) and two check sizes (15' and 60', equating to a fundamental spatial frequency of 2 cpd and 0.5 cpd respectively). The fellow eye was tested first. Measurements conformed to the ISCEV standards for clinical VEP recording. The non-viewing eye was occluded with a tight fitting opaque patch [7].

Contrast sensitivity measurements:

Contrast sensitivity was measured using a 10 cpd Gabor patch (radius 1.3°, sigma 1°), presented on a uniform grey background (50 cd/m2) for 500 ms within a Gaussian temporal envelope (100 ms ramp up and 100 ms ramp down) [8]. On each trial, participants judged the orientation of the patch (vertical vs. horizontal). Stimuli allowed for 10.8 bits of contrast resolution and presented on an Eizo CRT monitor (1024 × 768 resolution, 120 Hz refresh rate). The viewing distance was 100 cm and a tight-fitting opaque patch was worn over the non-viewing eye, so each eye was examined separately [7].

A two-alternative forced choice (2AFC) paradigm and a 2-down- 1-up adaptive staircase procedure (proportional step size of 25% before the first reversal and 7.5% increments and 15% decrements after the first reversal) were used to measure detection thresholds [7].

Equipment:

The metrovision scan version 8000F (Metrovision, Francais) in the Clinical Neurophysiology Unit, Kasr El-Ainy Hospital, Cairo University.

Statistical methods:

Data were coded and entered using the statistical package for the Social Sciences (SPSS) version 28 (IBM Corp., Armonk, NY, USA). Data was summarized using mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Comparisons between quantitative variables were done using the non-parametric Kruskal-Wallis and Mann-Whitney tests [9].

Results

1- Visual acuity:

The visual acuity of the amblyopis eye was 0.45 +/- 0.18 and that of the fellow eye was 0.97 +/- 0.18.

2- PVEP:

The latency of P 100 of the amblyopic eye was delayed compared to the amblyopic eye using both check sizes 60’ and 15’ as shown in Fig. (1) and (2). The amblyopic eye showed P 100 latency 101.01 +/- 7.12 msec using check size 60’ and 105.76 +/- 9.3 msec using checksize 15’. The fellow eye showed P 100 latency of 96.25 +/- 5.3 msec using checksize 60’ and 97.32 +/- 5.19 msec using checksize 15’.

The amblyopic eye showed a relatively low amplitude P 100 response. It showed P 100 response with amplitude 13.69 +/- 4.39 μV using checksize 60’ and 13.65 +/- 5.07 μV using checksize 15’. The fellow eye showed P 100 response with amplitude 20.56 +/- 5.06 μV using checksize 60’ and 24.91 +/- 7.06 μV using checksize 15’.

3- Contrast sensitivity test:

The amblyopic eye showed reduced maximum and minimum contrast sensitivity compared to the fellow eye as shown in Fig. (3) and (4). The maximum contrast sensitivity of the amblyopic eye was 18.47 +/- 4.29 and the minimum contrast sensitivity was 9.43 +/- 4.51. The fellow eye showed maximum contrast sensitivity 22.73 +/- 4.3 and minimum contrast sensitivity 14.17 +/- 4.32.

Discussion

In this study the amblyopic eye showed an increases in P 100 latency and decrease in amplitude compared to the fellow eye. Also the contrast sensitivity test showed decreased values of the amblyopic eye compared to the fellow eye.

Azmy and Zedan, 2016 studied pattern visual evoked potentials in children with strabismic amblyopia and concluded that P100 latency was increased in the amblyopic eye with no significant difference in amplitude compared to the fellow eye [10].

It was found that P100 latency at the time of initial diagnosis was significantly related to the visual improvement after occlusion therapy or glasses in patients with strabismic, anisometropic, and isometropic amblyopia. Therefore, it was presumed that patients with a delayed P100 latency might have less visual improvement after occlusion therapy or glasses [11].

Mohammadi et al., 2019 compared P100 latency between amblyopic and non-amblyopic eyes showed the following results. By 1-cpd spatial frequency stimulus, latency was significantly delayed in amblyopic eyes at all contrast levels except for 100%, and there was a significant correlation between amblyopic and non-amblyopic eyes at all contrast levels. By 2-cpd spatial frequency stimulus, significant difference was only seen at 50% and 25% contrast levels. Nonetheless, by 4-cpd spatial frequency stimulus, there was no significant difference between two groups at any contrast level [12].

It was found that visual acuity quantification using absolute value of amplitude in pattern visual evoked potentials was useful in confirming subjective visual acuity for cutoff values > 5.77 μV in disability evaluation to discriminate the malingering from real disability [13].

Dahal et al., 2023 found that Amblyopic eyes showed reduced pattern VEP amplitudes and delayed peak latencies with significant associations with the foveal sensitivity [14].

The P-100 parameters were comparatively higher than conventional values. P-100 latency seemed to better correlate with myopia, while hypermetropia correlated with P-100 amplitude. P-100 amplitude appears to be the most significant predictor of the presence of refractive error in an individual [15].

Repka et al., 2009 found that there was a weak correlation between the interocular contrast sensitivity difference and the interocular visual acuity difference [16].

Conclusion

VEP and CS tests could be used to assess the prognosis of patients with anisometropic amblyopia.

List Of Abbreviations

μV .... Microvolts

2AFC .... Two alternative forced choice

cds/m2 .... Candelasecond/meter squared

cm .... Centi meters

cpd .... Cycles per degree

CRT monitor .... Cathode ray tube monitor

CS .... Contrast sensitivity

fig......................... Figure

Hz .... Hertz

ISCEV .... International Society for Clinical Electrophysiology of Vision

max .... Maximum

min .... Minimum

ms .... Milli seconds

SD .... Standard deviation

SPSS .... Statistical package for the social sciences

VA .... Visual acuity

VEP .... Visual evoked potential

VER .... Visual evoked response

Declarations

Author Contribution

E and M prepared figures E,D , A and R wrote the manuscript

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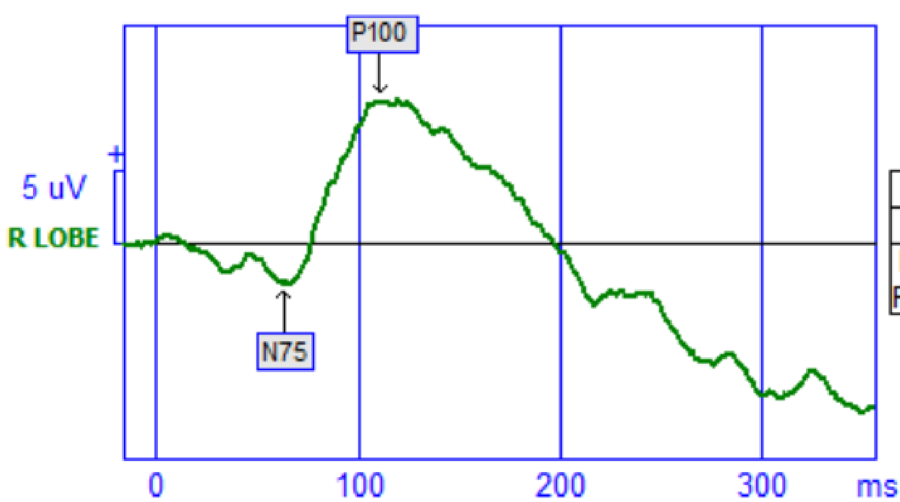
Figures



R LOBE			
N°	ms	uV	%
N75	61.3	-2.5	99
P100	109	11.7	99

Figure 1

PVEP of an amblyopic eye

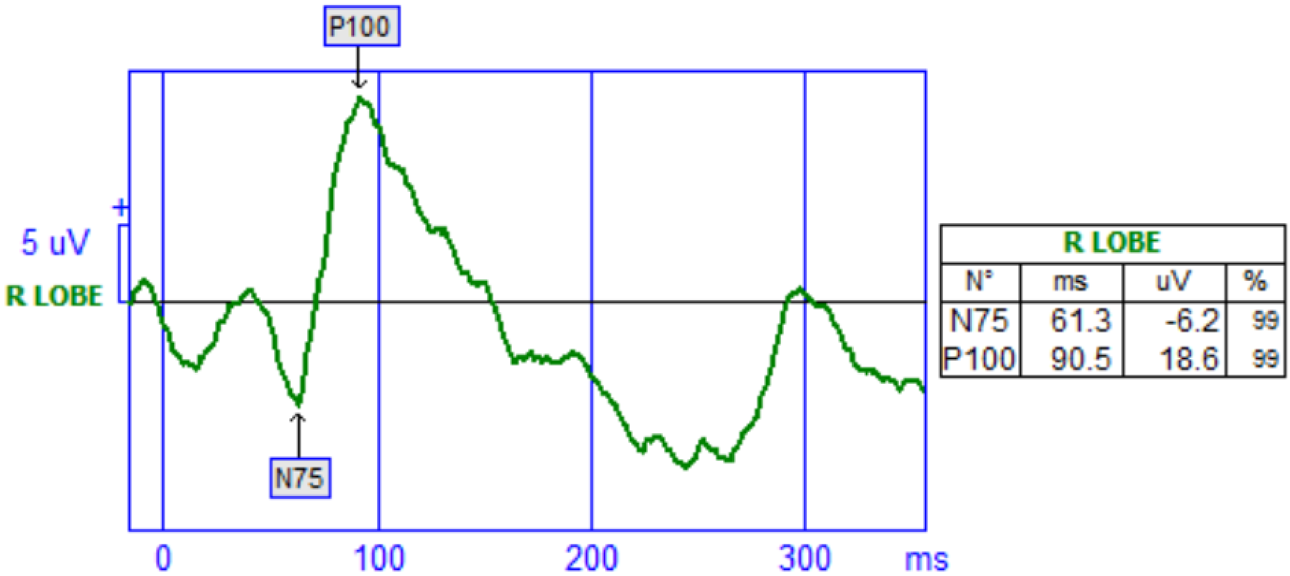


Figure 2

PVEP of the fellow eye

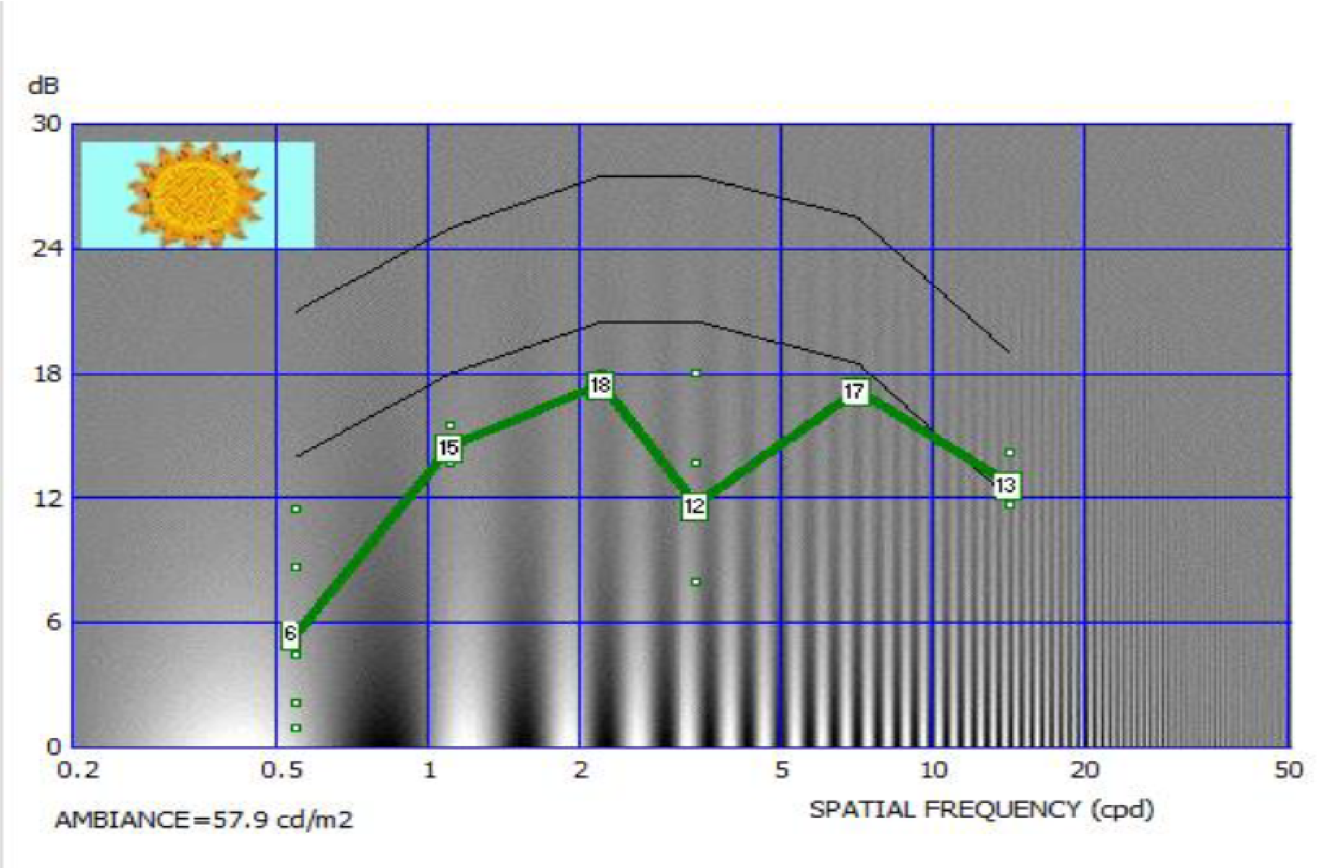


Figure 3

Contrast sensitivity test of an amblyopic eye

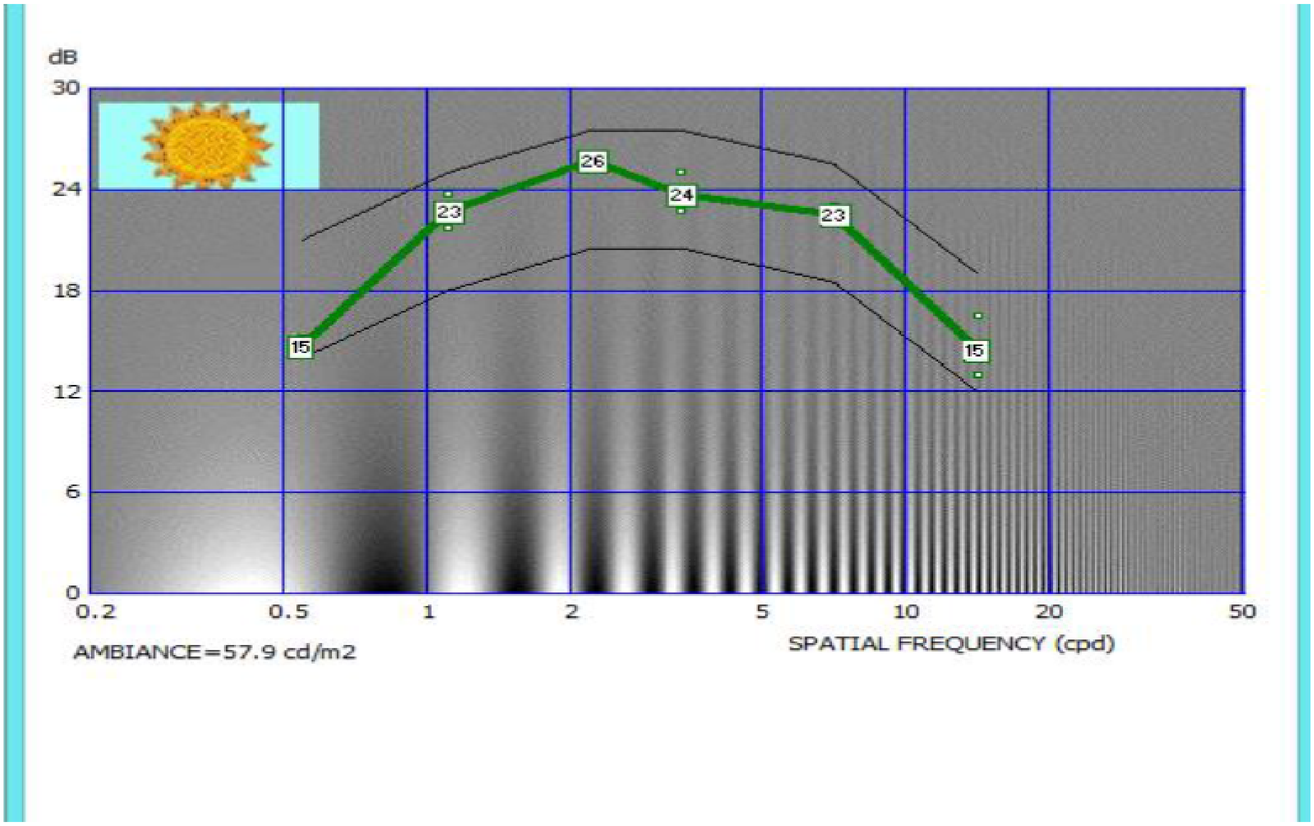


Figure 4

Contrast sensitivity test of the fellow eye