Visual Acuity and the Flash Visually Evoked Cortical Potential in Albinos

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The flash visually evoked cortical potential (VECP) was recorded in 18 human albinos. In some individuals P2 (latency 100–120 msec) formed the major component while in others P1 (latency 60–80 msec) was the largest component and dominated the response. The relative amplitude of P1 compared to P2 was calculated, and the results compared to the levels of monocular Snellen Visual Acuity measured. A relationship was found such that the greater the amplitude of P1 compared to P2, the lower the level of acuity. (Group 1: \( r_s = -0.509, P < 0.05 \). Group 2: \( r_s = -0.536, P < 0.05 \)). Invest Ophthalmol Vis Sci 27:222–225, 1986

The major ocular defect associated with albinism in humans is a reduction in visual acuity (VA). The level of VA recorded, however, falls within a wide range varying from 6/9 to less than 6/60.1–7 Ophthalmoscopic examination of the albino eye reveals a lack of the normal foveal hyperpigmentation and reflex with the area appearing hypoplastic. These findings are thought to ; almost universal within the albino population.7,8 Microscopic examination further shows that in the central retina the ganglion cell layer retains its maximum 6- to 8-cell layer thickness with no apparent foveal pit.9,10 Neither a rod-free area or typical cylindrical central cones are found, and instead the central cones resemble those found in the normal parafovea.11 Thus, there appears to be an anatomical defect responsible for the reduction in VA. However, it is still not apparent to why, if such an abnormality is present in all albinos, the VA is only mildly defective in some individuals yet grossly reduced in others.12 The presented study suggests that the severity of the central retinal defect may vary between albinos, this variation being reflected in the morphology of the flash VECP.

The typical flash VECP recorded in normally pigmented individuals consists of three early components: P1, N2, and P2, the latter of which, at least until middle age, is the largest and most consistent component.13–15 After this age the amplitude of the early P1 component increases such that it may equal or even exceed that of the P2 component.15–19

Materials and Methods

Eighteen human albinos, 15 oculocutaneous and 3 ocular, ranging in age from 5–35 yr (mean 14.3 yr; see Table 1) were examined. The experimental procedure was fully explained to all subjects prior to investigation. Informed consent to continue was obtained from all subjects; in the case of children, from their parents.

Monocular VAs were measured using a standard 6-metre Snellen Chart; an identical chart was used to examine all subjects. Such testing was only undertaken after careful correction of any refractive error, an important provision since high refractive errors are common in albinos.1,2,4,5,20

Monocular flash VECPs were recorded after careful occlusion of the nonstimulated eye. All responses were recorded at least twice to ensure repeatability. Silver–silver chloride electrodes were attached to the scalp using collodion. Active electrodes were placed at O1 and O2 with reference electrodes at C3 and C4 respectively (10/20 system).21 Each electrode was filled with electrode jelly and the scalp abraded to maintain an electrode resistance of 5 Kohms or less. Flash stimulation was delivered by a Grass PSII photostimulator (Grass; Quincy, Mass.) at setting 2 (1.363 cd/m²) stimulation rate 1.8 flashes per sec and situated 50 cm from
the eye of the subject. A total of 50 responses was averaged by a Nicolet Pathfinder II (Nicolet; Madison, WI) with a sweep time of 500 msec and a bandpass of 0.5 to 30 Hz. All responses were measured using the averager’s internal cursor.

**Results**

The monocular VAs recorded varied widely ranging from 6/18 to 2/60. The VECP results showed that the morphology of the responses differed greatly between albino subjects. Analysis of the albino responses was limited to that obtained over the hemisphere contralateral to the eye stimulated, that is, over the left hemisphere on right eye stimulation and over the right hemisphere on left eye stimulation. Due to the misrouting of optic nerve fibers at the chiasma in albinos, the monocular response is dominated by that recorded over the contralateral hemisphere. 22-25

Figure 1 shows three albino monocular responses obtained; the morphological type is that expected from such a young population. The major component is P2 preceded by a smaller amplitude PI. In contrast, Figure 2 shows three examples of albino responses of unexpected waveform. In these cases the response is dominated by a large amplitude P1 followed by a much reduced P2 component. Examination of the albino responses suggested that in those subjects where PI formed the dominant component, the VA was particularly reduced and at the lower end of the range of VA measured. In contrast, where P2 was the major component, the VA tended to be somewhat less reduced.

In order to investigate this relationship further, the relative amplitude of PI compared to P2 was calculated for each eye examined. This measure was termed the PI quotient (Plq). The peak to peak P1N2 and N2P2 amplitudes were measured and the Plq expressed as P1N2 amplitude/N2P2 amplitude X 100. Hence the larger the Plq, the greater the amplitude of PI compared to P2. To aid statistical analysis further, the VA measures were converted, by the means of tables, to decimal values. 26

For statistical analysis, the 36 eyes were divided into 2 sample groups. The subjects were initially listed in alphabetical order of surname, and one eye (right or left) for each was chosen randomly and placed in group one. The remaining eyes formed group two. The Plq quotient and VA is given for each eye with the age of the albino in whom the observations were made.

**Table 1. The calculated PI quotients and corresponding visual acuities for 36 albino eyes**

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plq*</td>
<td>V.A.†</td>
</tr>
<tr>
<td>20</td>
<td>289</td>
<td>0.10</td>
</tr>
<tr>
<td>21</td>
<td>988</td>
<td>0.10</td>
</tr>
<tr>
<td>9</td>
<td>33</td>
<td>0.17</td>
</tr>
<tr>
<td>6</td>
<td>40</td>
<td>0.17</td>
</tr>
<tr>
<td>12</td>
<td>51</td>
<td>0.33</td>
</tr>
<tr>
<td>16</td>
<td>138</td>
<td>0.17</td>
</tr>
<tr>
<td>11</td>
<td>44</td>
<td>0.10</td>
</tr>
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</tr>
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<tr>
<td>5</td>
<td>17</td>
<td>0.17</td>
</tr>
<tr>
<td>8</td>
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<td>0.10</td>
</tr>
<tr>
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<td>35</td>
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<tr>
<td>16</td>
<td>289</td>
<td>0.10</td>
</tr>
</tbody>
</table>

* = PI quotient.
† = visual acuity.

The results are divided into two sample groups. For each subject one eye was randomly selected and placed in group one. The remaining eyes formed group two. The Plq quotient and VA is given for each eye with the age of the albino in whom the observations were made.

![Fig. 1](image-url). In these three individual albino eyes the flash responses have the configuration expected in a young population. The waveform is dominated by a large amplitude P2 component preceded by a much smaller P1. The VA of each of these eyes was 0.33.
Fig. 2. The responses of these individuals do not conform to the usual configuration. The responses are dominated by a large P1 component followed by a P2 of much reduced amplitude. The VA of each of these eyes was 0.10.

tients and visual acuities of the eyes within the groups are given in Table 1. The data was subject to the Spearman rank-correlation test giving results of $r_s = -0.509$ ($P < 0.05$) for group 1 and $r_s = -0.536$ ($P < 0.05$) for group 2.

Discussion

Statistical analysis of the results indicates that there is a significant relationship between the size of the P1q and the VA measure, such that the greater the P1q the lower the VA. The existence of such a relationship does not necessarily indicate a causal link, although the results can be compared to those obtained when the flash VECP is recorded in the presence of other central vision defects.

It is generally accepted that the P2 component of the flash VECP is unaffected by the level of VA,\(^\text{13,17,19,27}\) however, in this study, the presence of low VA did not affect the recordability of the response but was associated with a change in the waveform morphology. A reduced P2 component is, however, found in the presence of macular disease;\(^\text{15,28}\) the results obtained in albinos may be a further reflection of this waveform alteration. One hypothesis is that the degree of macular abnormality in some albinos may be very severe, resulting in a particularly low VA and a large P1q. In others the defect may be less severe, giving comparably better vision and a VECP of more normal morphology. Although in the case of albinos features such as high refractive errors and squints may cause some degree of anisometric and strabismic amblyopia respectively, thus further reducing the VA measure, the explanation of the existence of varying degrees of macular defect may be the underlying reason for the differing levels of VA recorded in such individuals.

**Key words:** albinism, visually evoked cortical potential, visual acuity

**References**