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Electronystagmographic investigation in X-linked ocular albinism

R. Salati[1]
R. Magni[1]
M. Musolino[2]
P. Nucci[2]
F. Polenghi[1]

[1]Department of Neuro-ophthalmology, Scientific Institute 'E. Medea', La Nostra Famiglia, Bosisio Parini (Lc) and [2]Department of Ophthalmology and Visual Sciences, H.S. Raffaele, Milano, Italy

Abstract Albinism represents the most frequent cause of nystagmus induced by visual sensory disorders. We studied five patients aged between three and five years with ocular albinism with the aim of identifying the characteristics of nystagmic oscillations. The patients underwent complete ophthalmological examination and electronystagmography (ENG). ENG revealed either pendular or jerk waveforms (or both) with the same complex effects of fixation seen in those with idiopathic congenital nystagmus. Three children presented face turn due to reduced severity of nystagmus in latero-version. Latent nystagmus was not observed.

Key words Nystagmus; albinism; X-linked albinism; eye movement recording

Correspondence to: Roberto Salati M.D., Settore di Ricerca di Neuro-oftalmologia, Istituto Scientifico 'E. Medea', 22040 Bosisio Parini (LC), Italy. Tel: 39-31-877321 or 877111; Fax: 39-31-877499

Introduction Albinism is the cause of reduced vision in 5-10% of visually handicapped children. Its prevalence is about 1:20,000; 1:16,000 in Caucasian populations.[1] Classically, two main forms of albinism are described, oculocutaneous and ocular. The former is characterized by hypopigmentation of the skin, eye, and hair, by the risk of developing skin tumor, and by specific neuro-ophthalmological manifestation, while the latter has only visual system involvement. For genetic aspects and classification of the various forms of albinism, the reader is referred to specific papers on these topics.[1-4] The ophthalmologic characteristic of albinism may be summarized as follows. Visual acuity is always severely reduced. The visual deficit is attributable both to anatomic defect of the afferent visual pathway and to the presence of nystagmus. The iris appears as a fine, depigmented, gray diaphanous membrane; the lack of pigment in the posterior surface results in marked transillumination, with a typical aspect of 'rayon de roue'. Depigmentation of the ocular fundi is always present, although the degree of depigmentation may vary considerably. The choroidal vessels are abnormally evident, whereas the retinal ones appear slender. Fundal depigmentation is almost always associated with foveal

hypoplasia. The latter phenomenon has been confirmed by histopathology.[2]

Visual evoked potential (VEP) testing demonstrates specific anomalies such as a marked hemispheric asymmetry at monocular stimulation. In fact, in the albino the majority of ganglion cell axons decussate at the optic chiasm and project to the contralateral geniculate nucleus, with resultant anomalous field representation to the visual cortex. Thus, VEP recordings show a greater amplitude in the hemisphere contralateral to the stimulated eye.[5,6] Electroretinographic tracing may be of great amplitude, although such anomalies are not specific. Contrast sensitivity is altered, being worse for vertical than for horizontal stimuli.

Photophobia is very severe and patients require lenses with elevated light filtering power. Refractive errors, such as hyperopia and astigmatism, are frequent. Strabismus is present in 70% of cases, generally as esotropia.[1] Albinos lack the anatomic substrate to develop binocular vision, and therefore stereotests give negative result.[5]

Most albinos exhibit congenital nystagmus (CN), which generally appears in the first year of life. Few specific studies are available on nystagmus in albino patients; however, several reports agree that both pendular and jerk waveforms and waveforms with extended foveation may be seen in this population and that it is reduced in near vision.[7-20]

In this retrospective study, we examined the electronystagmographic findings of five pediatric patients affected by ocular albinism with the aim of documenting the characteristics of nystagmic oscillation and any specific anomalies that distinguish nystagmus of the ocular albinos from CN in others.

Materials and methods We studied five children aged between three and five years affected by X-linked albinism. They all underwent a complete ophthalmological examination and electronystagmography (ENG).[21]

ENG was performed with a modified ACEM type T3 electroencephalograph. The filters were set at 0.3 to 300 Hz. The ENG were recorded with curvilinear pens. Calibration was performed by asking the patient to look at targets that are placed in the primary position and at 10° horizontally. The angle between the targets corresponded to 1 cm on the recording paper. The same procedure was followed with two targets vertically positioned for vertical tracings. The paper speed was 1.5 cm per second.

The examination consisted of three phases: mesopic, scotopic, and photopic. Four channels were used with bipolar electrodes placed respectively above and below each eye on an imaginary vertical line passing through the pupil, and at the inner and outer corners of each eye to record horizontal movements. The ground electrode was placed in a mediofrontal position. Electrode impedance was always under 5 Kohms. The first tracing at the top and the last tracing at the bottom show vertical versions of each eye; an upward eye movement causes an upward deflection of the tracing. The second and third tracings show horizontal versions of each eye; an eye movement towards the right corresponds to an upward deflection of the tracing. Separate analysis of the horizontal and vertical movements of each eye reveals any interocular difference and is useful to differentiate artifacts which generally differ in the various leads. The vertical ENG contains lid artifacts that distort the eye movement signal. Vertical recording was performed in order to verify both the presence of the vertical component of nystagmus and the reliabil-

Case	VA *binocular*	VA RE	VA LE	AHP
1	20/200	15/200	15/200	Turned right
2	20/1000	–	–	Turned left
3	20/200	20/200	20/200	Turned right
4	20/50	20/50	20/50	No
5	20/200	–	–	No

TABLE 1. Data concerning monocular (right eye, RE and left eye, LE) and binocular visual acuity (VA), and the anomalous head position (AHP) presented by the subject.

ity of the horizontal tracing, knowing that the artifacts were due to blinking.

The equipment used for this study was unable to accurately show if the slow phases of the nystagmus were linear or exponentially increasing or decreasing.

In evaluating the characteristics of nystagmus, we concentrated particularly on identifying gaze positions in which nystagmus decreased or disappeared. For this purpose, we recorded nystagmus during versions from 30 degrees to the right to 30 degrees to the left. Convergence was studied in dynamic fashion, moving the target of fixation progressively up to a distance of 15 cm. Latent nystagmus was also evaluated.

Case reports Data regarding visual acuity, refraction, and strabismus are presented in Tables 1, 2, and 3.

CASE 1 A five-year-old boy with ocular albinism was diagnosed at age one year. The patient did not present an anomalous head position, but when asked to read at distance he turned his head about 15° to the right. Iris pigmentation was minimal. OU fundus oculi: absence of retinal pigmentation and macular hypoplasia. Lang stereo test showed absent stereopsis.

ENG showed jerk right with extended foveation and right pseudocycloid nystagmus in all positions of gaze (frequency 3 Hz, amplitude 4°-6°) (Fig. 1). We observed an appreciable reduction in severity of nystagmus in left gaze of about 20° (frequency 3Hz, amplitude 2°), which was the head position preferred by the patient. Latent nystagmus was not present. Nystagmus reduced in convergence. The same CN waveforms persisted in scotopic conditions.

CASE 2 Ocular albinism was diagnosed in a three-year-old boy after nystagmus had appeared at two months of age. There was a rather complete depigmentation of the iris and complete depigmentation of fundus oculi. Foveal hypoplasia was observed. The head was turned to the left with chin down during reading at distance. Lang stereo test: absence of stereopsis.

Case	*Refraction* RE	*Refraction* LE	PCT *at distance*	PCT *at near*
1	−3.5/−3.5axis180	−4.0/−2.5axis180	–	–
2	+2.5axis90	+0.5/+3.0axis90	–	–
3	+4.0/+2.0axis90	+4.0/+2.0axis90	–	–
4	+1.5sph	+1.5sph	–	–
5	+2.5/+1.0axis95	+2.5/+2.0axis80	+16D	+20D

TABLE 2. Data concerning refraction (right eye, RE and left eye, LE) and cover test (prisma cover test, PCT).

TABLE 3. Nystagmus waveforms in the subjects. ny, nystagmus; lg, lateral gaze; p, pendular; ppfs, pseudopendular with foveating saccade; jef, jerk with extended foveation; pc, pseudocycloid; dj, dual jerk; j, jerk.

Case	*Kind of ny*	*Reduction at near*	*Reduction in lg*	*Latent ny*
1	jef, pc	+	Right 20°	–
2	p	–	Right 25°	–
3	p, dj	–	Left 20°	–
4	ppfs, j, jef, pc	+	–	–
5	dj, ppfs	–	–	–

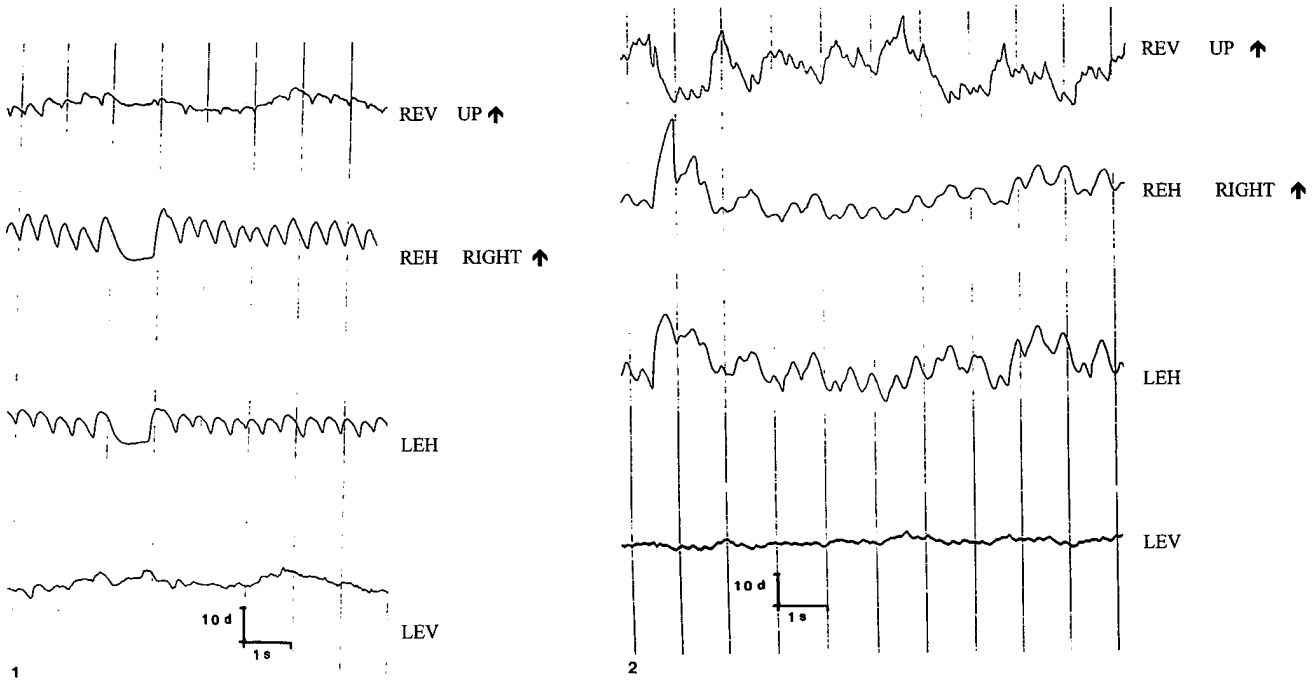
ENG documented that the only waveform was pendular (Fig. 2). Nystagmus was slightly reduced in right lateroversion of about 25° and not modified by convergence. Latent nystagmus was not found. Nystagmus was pendular in scotopic conditions.

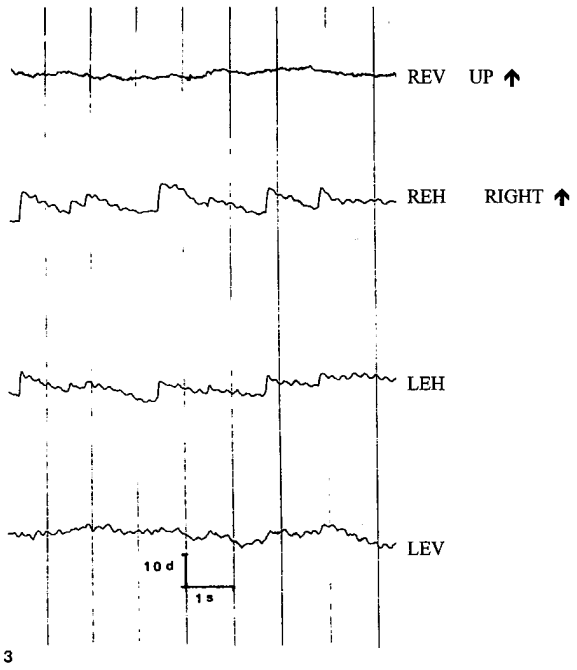
CASE 3 The five-year-old brother of Case 2 had a diagnosis of ocular albinism made at one year. Nystagmus had developed at about eight months of age with very rapid, frequent oscillations that reduced in severity over time. Marked depigmentation of the irises and fundi oculi were observed as was foveal hypoplasia. The child presented an anomalous head position, turned to the right by about 20°. Lang stereo test: absence of stereopsis.

ENG revealed pendular nystagmus (frequency 5-7 Hz, amplitude 2°-4°) and dual jerk nystagmus (amplitude up to 25°) occurred at intervals, especially during right lateroversion and fixation (Fig. 3). Latent nystagmus was not detected. The severity of nystagmus was reduced in left lateroversion of about 20° (frequency unchanged, amplitude 3°-4°), the position adopted by the patient to improve visual acuity. It was not modified in convergence. In the dark, only pendular nystagmus was observed.

Fig. 1. Case 1. Jerk (RE) and jerk with extended foveation (LE) and pseudocycloid (OU) nystagmus in the light. REV, right eye vertical tracing; REH, right eye horizontal tracing; LEH, left eye horizontal tracing; LEV, left eye vertical tracing.

Fig. 2. Case 2. Pendular nystagmus in the light. See Figure 1 for abbreviations.





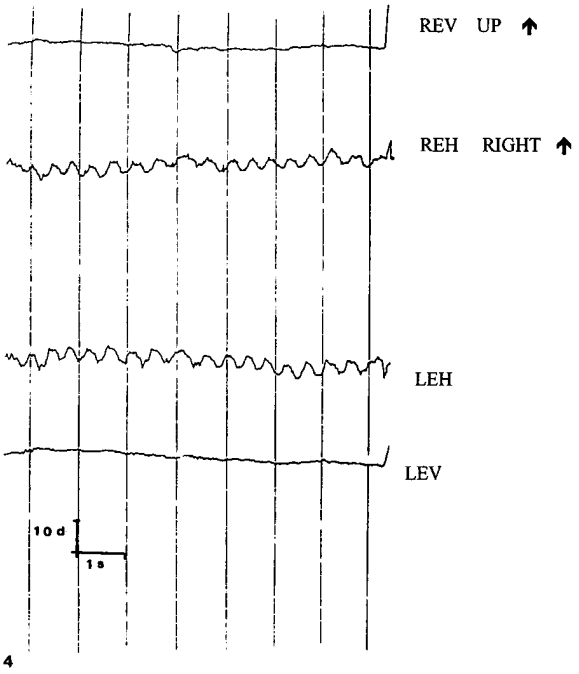


Fig. 3. Case 3. Dual jerk (high-frequency, low-amplitude pendular superimposed on low-frequency, high-amplitude jerk) in the light. See Figure 1 for abbreviations.

Fig. 4. Case 4. Pseudopendular nystagmus with foveating saccades in the light. See Figure 1 for abbreviations.

CASE 4 A five-year-old boy had ocular albinism diagnosed at age one year following the appearance of nystagmus. The irises presented moderate depigmentation with partial transillumination. The fundi were depigmented, and the macula was poorly defined with no macular reflexes. Lang stereo test: absence of stereopsis.

ENG demonstrated pseudopendular nystagmus with foveating saccades (a bidirectional jerk waveform) (frequency 2 Hz, amplitude 10°) (Fig. 4) with jerk, jerk with extended foveation, and pseudocycloid nystagmus in lateroversion (frequency 5 Hz, amplitude 8°-10°). The presence of foveating saccades permitted good visual acuity. During convergence, jerk with extended foveation, pseudocycloid, and pseudopendular with foveating saccades (all jerk waveforms) were seen. Latent nystagmus was not present. Nystagmus was prevalently pendular in the dark.

CASE 5 Ocular albinism was diagnosed in this three-year-old boy. Nystagmus appeared a few weeks after the birth. The child had hypopigmentated irises and fundi oculi, associated with macular hypoplasia. No anomalous head position was adopted. Lang stereo test: absence of stereopsis.

ENG showed both dual jerk nystagmus, in all the positions of gaze, and pseudopendular with foveating saccades. The dual jerk had a pendular frequency of 3-4 Hz and amplitude of 10°-15° with superimposed jerks of wide amplitude (20°-25°) (Fig. 5). Nystagmus did not decrease in convergence. Latent nystagmus was not detected. No position of gaze could be identified in which nystagmus was reduced in severity. Pendular nystagmus was present in the dark with the same characteristics as observed in the light.

Discussion Nystagmus in our series presented the following features: it appeared within the first 12 months of life, was binocular, horizontal, conjugate, similar in the two eyes, and reduced in convergence, and oscillopsia was not present.

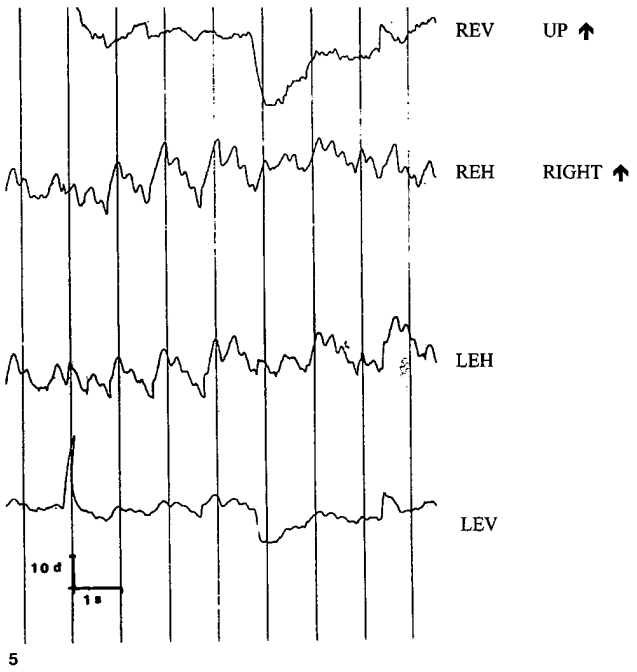


Fig. 5. Case 5. Dual jerk and pseudopendular with foveating saccades nystagmus in the light. See Figure 1 for abbreviations.

Albinos with CN can have either pendular or jerk waveforms (or both) with the same complex effects of fixation seen in patients with idiopathic CN. This, therefore, further discredits the old impression (based only on clinical observation) that CN associated with afferent visual deficits is pendular, while CN not associated with such deficits, is jerk.

Strategies to improve fixation are typical of CN and have previously been documented in ocular albinos. Three of our patients (Cases 1, 2, and 3) were observed to assume particular positions of the head to improve visual acuity. In this position, in all three cases, ENG demonstrated that the amplitude and frequency of nystagmus was reduced, with subsequent improved foveation. Convergence reduced the severity of nystagmus in two patients, but did not modify it in the other three. Latent nystagmus was not detected in any of the patients, not even in the one with esotropia.

ENG is considered a safe, established technique that allows recording of ocular movements. It is recommended in patients who might undergo surgery for CN and provides useful information for the diagnosis of the disorder and the positions in which nystagmus damps. It is also helpful in planning surgery. Albinos, as other subjects with CN, may benefit from surgical correction of anomalous head position.

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