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Foveation Period and Waveforms of Congenital Ocular Nystagmus

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A B S T R A C T

Normal visual acuity requires a stationary retinal image on the fovea. If fixation instabilities cause movement of the retinal image across the fovea for a few degrees, visual acuity is diminished. Nystagmus as the fixation instability, consequently, may impair vision.Period of foveation is the area in the wave form, i.e. a brief period of time when the eye is still and is pointed at the object of regard. At this period eye velocity is at a minimum and visual acuity is the best. In the children with congenital ocular nystagmus, using usual clinical equipment (TC 1.0 and TC 0.3 s), was performed electronystagmography (ENG) and analysis of the obtained nystagmus waveforms. In the some patients visual acuity was also examined. The ENG records were classified according to Dell'Osso criteria for waveforms. The findings of jerk nystagmus with extended foveation (J_{EF}) and of bidirectional jerk nystagmus (BDJ) were singled out. Foveation time, measured in these weveforms was compared with the visual acuity. Visual acuity was better in the jerk nystafmus weveforms with extended foveation period (J_{EF}) than in bidirectional jerk nystagmus with shorter foveation time.

Key words: *foveation, congenital ocular nystagmus, waveforms*

Introduction

Optimum vision and perception of the surrounding space call for a stable image of the subject of perception that is generated on the retina. For an object to be perceived clearly its image must rest on the point of clearest vision at the centre of the retina, which is the fovea centralis. The task of the oculomotor control systems to position of image of a given object on the fovea centralis and, once the image has been positioned, to keep it in that position. After the ocular muscles have directed the eyes towards the target so that the image of a certain point rests on the fovea, the image tends to stay there. However, even when gazing fixedly, in the calmest and most attentive manner, the eyes are never at rest but are in the process of continually making tiny movements. Two types of movement can be distinguished: micromovements (drifts), i.e. slow movements which are meant to remove the retinal image from the fovea by sliding, and rapid movements, microsaccades, which are refixing movements, with the task of returning the retinal image to the centre of the fovea and of preventing sliding more than of 5 angular minutes[1,2].

Normal visual acuity requires the image on the fovea to be fixed. If fixation instability causes the retinal image to move across the fovea at the velocity of a few degrees per second or higher, visual acuity becomes reduces. The nystagmus oscillations are therefore held responsible for diminished visual acuity[3]. Nystagmus is caused by abnormal functioning of the system of slow ocular movements[4]. Abnormal slow eye movements take the eyes off the intended gaze direction. Rapid eye movements, or slow eye movements in the opposite direction, return the eyes to the right direction. Nystagmus can present in two waveforms: pendular nystagmus, which is characterized by to-and-fro movements of equal velocity, and jerk nystagmus, which consists of a slow initial movement in one direction followed a rapid return in the opposite direction[5].

Among the most important clinical characteristics of congenital nystagmus are diminished visual acuity, frequent association with strabismus, compensatory head posture, possible presence of the null or neutral nystagmus zone, etc[6]. Congenital nystagmus is known to exihi-

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bit a number of different waveforms. Several have been reported in literature[7,2]. The classification of the nystagmus waveforms by Dell'Osso and Daroff[8], published in 1975, has proved to be very applicable. According to that classification there are three groups of nystagmus: pendular nystagmus, jerk nystagmus involving a slow movement in one direction, and bidirectional jerk nystagmus. In congenital nystagmus are frequent certain specific forms, which come as a result of efforts to amend visual acuity[9]. Nystagmus as fixation instability causes poor visual acuity. So, to achieve better visual acuity, certain correctional movements are generated which aim at improving fixation, i.e. keeping the eye directed toward the object of fixation, as long as possible. The brief period of time, within the nystagmus wave, when the eye is directed towards the fixation target, is known as the foveation period[8,10–12].

Daroff and co-workers have given graphic illustration of foveation using cases of pendular (P) and simple jerk nystagmus (J) as examples (Figure 1)[13]. In the course of nystagmus oscillations, the image of the object of fixation rests on the fovea only when the visual line is directed at the target. Evidently, those periods are very brief and visual acuity is consequently poor. Some forms of unidirectional jerk nystagmus are marked by extended foveation (J_{EF}), but there are also jerk forms that comprise a slow-moving phase which accounts for prolonged resting of the image on the fovea. Those are known as pseudocycloid (PC) and pseudojerk (PJ) forms[8, 9]. In the bidirectional nystagmus group the presence of the forms with foveation has also been reported, especially for pseudopendular nystagmus with foveation saccade (PP_{FS}), and for bidirectional jerk nystagmus (BDJ)[8,9].

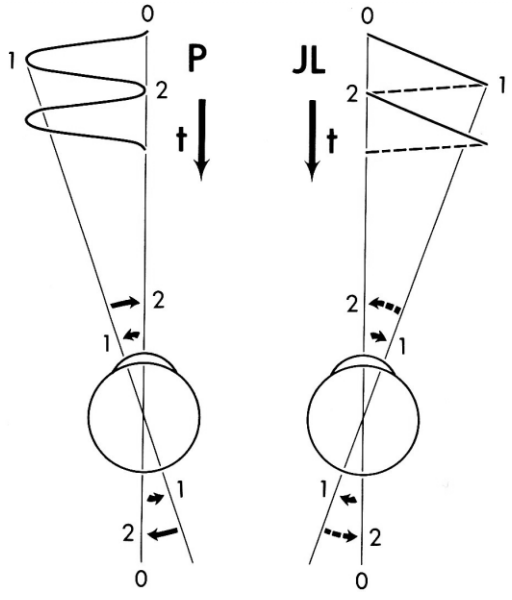

Fig. 1. Foveation in pendular (P) and jerk left (JL) nystagmus. The image of an object of regard rests on the fovea only when the visual line, during the time of nystagmus oscillations is directed at the target, i.e. the target is only briefly foveated at points 0, 2, etc., t = time scale[13].

The aim of this investigation was to single out some forms of jerk nystagmus with foveation, to analyse the duration of the foveation period and to compare it with the visual acuity in children with that nystagmus waveform.

Materials and Methods

In our electronystagmographic studies of congenital ocular nystagmus in children, published earlier, unidirectional nystagmus was present in 38% of the children, and bidirectional forms of nystagmus were found in 25% of the children[14,15]. From the group of unidirectional jerk nystagmus we singled out those with extended foveation (J_{EF}). They were 10%[14]. In the group with bidirectional nystagmus 3% of the children had bidirectional jerk nystagmus (BDJ)[14].

With the aid of computer we were able to enlarge the nystagmus waveform and oscillations and thus make an accurate assessment of the time (duration) and the number of foveation periods. Nystagmus intensity (I = amplitude in degrees x frequency in Herz) was calculated according Kestenbaum[16].

Results and Discussion

Our results show that in cases of jerk nystagmus with extended foveation (J_{EF}) the mean duration of the foveation period was from 170–220 msec (Mean 191.3±23 msec). Measurements of the nystagmus amplitude and frequency showed the intensity to be 34° (Figure 2). The best mean visual acuity in our subjects, measured at

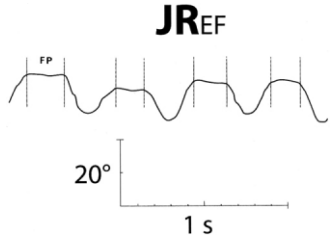

Fig. 2. Unidirectional jerk right nystagmus with extended foveation (JR_{EF}). Foveation period 170–220 msec, Mean 191.3±23 msec; nystagmus intensity 34°; visual acuity 0.5. FP = time measured in the foveation period.

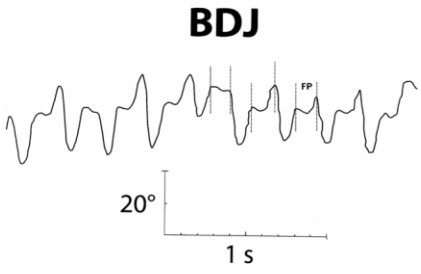

Fig. 3. Bidirectional jerk nystagmus (BDJ). Foveation period 125–140 msec, Mean 131.6±7.6 msec; nystagmus intensity 89°; visual acuity 0.3. FP = time measured in the foveation period.

straight head, or compensatory head position, was 0.5. This example shows that despine the inability to maintain steady fixation congenital nystagmus does not necessarily considerable reduce visual acuity that can be achieved during foveation periods[17,18].

In the case of bidirectional jerk nystagmus (BDJ) (Figure 3) the foveation period was shorter, 125–140 msec (Mean 131.6±7.6 msec), nystagmus was faster, and the nistagmus intensity was 89°. The best mean visual acuity was 0.3.

Conclusion

We may conclude, that the relationship between the duration of foveation period and visual acuity demonstrated that the visual acuity is better, when the foveation period is longer, i.e. the longer the time the image of the fixation object is maintained on the fovea.

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PERIOD FOVEACIJE I OBLICI KRIVULJE KONGENITALNOG OKULARNOG NISTAGMUSA

SAŽETAK

Normalna vidna oštrina zahtjeva na fovei stabilnu sliku gledanog objekta. Ako fiksacijske nestabilnosti uzrokuju pokret retinalne slike preko foveje, brzinom od nekoliko stupnjeva u sekundi ili više, vidna oštrina je smanjena. Zbog toga nistagmus kao nestabilnost fikascije uzrokuje smanjenje vidne oštrine. Kratki period vremena unutar vala nistagmusa, kada je oko usmjereno na fiksacijski objekt, naziva se period foveacije. U tom je periodu brzina očnog pokreta najmanja, te je i vidna oštrina bolja. U djece s kongenitalnim okulanim nistagmusom učinjena je, uporabom uobičajene kliničke opreme (TC 1.0 s i TC 0.3 s), elektronistagmografija i analiza oblika krivulja nistagmusa. U istih je pacijenata ispitana i vidna oštrina. Elektronistagmografski nalazi oblika krivulje nistagmusa klasificirani su prema Del'Ossovim kriterijima. Izdvojeni su nalazi trzajnog nistagmusa s produljenom foveacijom (J_{EF}) i nalazi bidirekcionalnog trzajnog nistagmusa (BDJ) te uspoređeni s vidnom oštrinom koju postiže dijete s tim oblikom nistagmusa. Vidna oštrina bila je bolja u slučajevima trzajnog nistagmusa s produljenim periodom foveacije (J_{EF}) nego kod bidirekcionalnog trzajnog nistagmusa (BDJ).