

Oculomotor evaluation in adults: a study of the effect of age and visual alterations

Avaliação oculomotora em adultos: um estudo do efeito da idade e de alterações visuais

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ABSTRACT

Purpose: To evaluate saccadic and pursuit ocular movements and optokinetic nystagmus in adults, analyzing the effect of age and visual alterations. **Methods:** We evaluated 40 subjects of both genders, aged 20–49 years, with no auditory or vestibular complaints and who presented a normal basic audiology evaluation, absence of spontaneous nystagmus with open eyes, semi-spontaneous nystagmus, and spontaneous nystagmus with eyes closed greater than 6°/s. All participants underwent the tests of spontaneous nystagmus, optokinetic nystagmus, fixed and random saccadic movements, and pendular tracking using computerized vectoelectronystagmography. The findings were analyzed according to age and visual changes (ametropias). The results underwent a descriptive and inferential analysis. **Results:** There was no difference in the tests of optokinetic nystagmus, fixed and random saccadic movement, and pendular tracking when analyzed with regard to age. As for the variable presence of visual alteration, directional preponderance of nystagmus, observed in the optokinetic nystagmus test, was higher in individuals with visual alterations. In the random saccadic movement, there was also a difference in relation to the maximum velocity, which was higher in individuals with no visual alterations. **Conclusion:** The oculomotor tests were not affected by the age factor in the studied age group, but the presence of visual alterations exerted influence on some of the parameters of the oculomotor tests.

Keywords: Nystagmus, physiologic; Nystagmus, optokinetic; Saccades; Postural balance; Reflex, vestibulo-ocular

RESUMO

Objetivo: Avaliar os movimentos oculares de sácadas, perseguição e o nistagmo optocinético em adultos, analisando o efeito da idade e das alterações visuais. **Métodos:** Foram avaliados 40 sujeitos de ambos os gêneros, com faixa etária de 20 a 49 anos de idade, sem queixas auditivas ou vestibulares e que apresentaram avaliação audiológica básica dentro dos padrões da normalidade e ausência de nistagmo espontâneo de olhos abertos, nistagmo semi-espontâneo e nistagmo espontâneo de olhos fechados maior que 6°/s. Todos os participantes foram submetidos às provas de nistagmo espontâneo, nistagmo optocinético, movimentos sacádicos fixos, aleatórios e rastreo pendular, por meio da vectoelectronistagmografia computadorizada. Os achados foram analisados segundo as variáveis idade e presença de alteração visual, do tipo ametropias. Os resultados passaram por análise estatística descritiva e inferencial. **Resultados:** Não houve diferença nas provas de nistagmo optocinético, sacádico fixo, aleatório e rastreo pendular, quando analisadas com relação à idade. Quanto à variável alteração visual, a preponderância direcional do nistagmo, observada na prova do nistagmo optocinético, foi maior em indivíduos com alterações visuais. Nos movimentos sacádicos aleatórios, também se observou diferença em relação à velocidade máxima, sendo maior em indivíduos sem alterações visuais. **Conclusão:** As provas oculomotoras não sofreram influência do fator idade na faixa etária pesquisada, porém, a presença de alterações visuais exerceu influência em alguns dos parâmetros das provas oculomotoras.

Descritores: Nistagmo fisiológico; Nistagmo optocinético; Movimentos sacádicos; Equilíbrio postural; Reflexo vestibulo-ocular

Study conducted in the Speech and Hearing Therapy Course, Universidade Federal de Santa Catarina – UFSC – Florianópolis (SC), Brazil.

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Conflict of interests: No

Authors' contribution: VPG was responsible for data collection and analysis and manuscript preparation; RS was responsible for guiding the elaboration of the study, data analysis, and manuscript preparation.

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Received on: 4/13/2016; **Accepted on:** 7/6/2016

INTRODUCTION

Body balance is directly related to the integration between the vestibular, visual, and proprioceptive systems. The information generated by these receptors is conducted to the central nervous system (CNS), which organizes and processes them, promoting balance maintenance⁽¹⁾.

In the visual system, the retina has a good resolution at its center, *i.e.*, the fovea, and a lower resolution in its periphery. Therefore, a complex ocular movement is required to maintain a large field of view on the object of interest. In order to maximize foveal vision, the fovea must have the ability to quickly align with the desired objects and maintain this alignment for a sufficient period to allow the visual system to perform a detailed analysis of the image⁽²⁾.

During natural head movements, the eyes are required to make compensatory movements, keeping a clear vision. This ocular movement is reflexive and known as vestibulo-ocular reflex (VOR), which ensures a stable image⁽³⁾.

Six systems control these movements: the fixation system, which preserves the image of stationary objects in the fovea; the vestibular system, which maintains objects stable in the center of the retina during short head movements; the optokinetic system, which preserves the image of the object stable in the retina during sustained head movements; the saccadic system, which performs rapid movements of the fovea toward an object of interest; the smooth pursuit system, which maintains an object in the fovea while this object moves slowly; and the vergence system, which moves the eyes in opposite directions, ensuring that the image is simultaneously maintained in both foveae⁽²⁾.

The most used test to assess the vestibulo-ocular reflex is electronystagmography (ENG), which captures through electrodermal potential corneoretinal variations during eye movement^(4,5).

Among the tests that make up the electronystagmography, the random saccadic movement test assesses CNS control in relation to rapid eye movement. The test is composed by visual stimuli presented in a bar with bright points while the ocular movements are captured. The stimuli are presented with random movements in terms of amplitude and time interval. The test analyzes parameters of latency, accuracy, and velocity⁽⁶⁾.

Another test is pendular tracking, which refers to the eye movement made to pursuit a moving target and assesses the integrity of the oculomotor system in controlling slow eye movement⁽⁷⁾.

The optokinetic nystagmus test assesses ocular movement, which aims to keep the image on the fovea, triggered by visual stimuli of bright spots moving right and left. The ocular movement comprises a slow component, which refers to the movement of the eyes in pursuit of the object, and a quick component, which represents the return of the gaze to another end⁽⁸⁾.

Through recordings of ocular movements by digital electronystagmography through the capture of corneoretinal variation, it is possible to perform an analysis of the oculomotor

movements, which are important for body balance, since we may indirectly obtain information on the vestibulo-ocular reflex (VOR). In this analysis, we obtain data on the parameters of latency, precision, velocity of the slow component of the nystagmus, velocity of saccadic movements, gain of pendular tracking and optokinetic nystagmus, and symmetry of the latter. The conduction of oculomotor tests during vestibular analysis by means of computerized equipment makes the assessment more sensitive to detect peripheral signals and, mainly, central signals, since it allows for an analysis of parameters such as movement velocity, latency, precision and gain, contributing to a more accurate diagnosis. Therefore, it is important to carry out studies about such tests in different populations with and without vestibular complaints and in different age groups, to define more rigid standard criteria, allowing the establishment of variations that interfere with the results, such as, for example, the presence of visual alterations.

The aim of this study was to study saccadic and pursuit ocular movements and optokinetic nystagmus in adults and to analyze the effect of age and visual disorders.

METHODS

This is a descriptive, quantitative, analytical, cross-sectional study performed in the Vestibulometry Section of the School-Clinic of Speech and Hearing Therapy Pathology of the *Universidade Federal de Santa Catarina* (UFSC) in the period from August to October 2015, after analysis and approval of the research project by the Research Ethics Committee at UFSC, under the number 1,183,096. The sample for this study was composed of 40 subjects (12 men and 28 women). The participants met the following inclusion criteria: 20 to 49 years of age; basic audiological assessment within normal standards^(9,10); absence of current or previous complaints of vestibular alterations; good general health status; absence of spontaneous nystagmus with closed eyes greater than 6°/s; absence of spontaneous nystagmus with eyes open and semi-spontaneous nystagmus⁽⁶⁾. The exclusion criteria were: use of medications acting on the central nervous system and diagnosis of neurological disease. All subjects who met the eligibility criteria were invited to participate in the research. Those who accepted read and signed the Informed Consent Form.

The study used the following procedures: application of a questionnaire and assessment of oculomotor movements.

The questionnaire comprised 18 questions related to socio-demographic aspects, daily habits (smoking, alcohol consumption, and practice of physical activity), complaints related to hearing, balance, and the presence of visual disorders.

Oculomotor movements were recorded using a computerized vectoelectronystagmography (VENG) with the Contronic SCE equipment, a BL-99 LED (Light Emitting Diode) bar and the *Nistagmus* software (version 1.1). Variations in corneoretinal electric potentials were captured by surface electrodes.

After skin cleaning, we placed four surface electrodes on the patient's face, including a ground wire and three active electrodes, two of them located in the periorbital region and one in the medium frontal line. Before collecting the data, we verified the impedance of the electrodes. For the calibration of the ocular movements, we carried out a fixed saccadic movement test in the horizontal and vertical planes using the LED bar positioned one meter away from the patient in the middle line of the eyes, so that the various tests were performed under the same conditions. The test was performed in a quiet room with low light.

We originally recorded the evaluation of spontaneous nystagmus with open and closed eyes, as well as the research on semi-spontaneous nystagmus, since the presence of these nystagmi could lead to the exclusion of volunteers from the study.

The first test was the fixed saccadic movement test. In this test, the movement of the target was fixed regarding the (horizontal) plane, the amplitude, and the velocity of displacement of the point on the luminous bar. The velocity of displacement of the visual stimulus was 0.5 Hz. In the random saccadic movement test, the target moved randomly in regards to the amplitude of displacement. Nonetheless, the velocity remained fixed at 1 Hz, as well as the horizontal plane. The parameters analyzed were: maximum dislocation velocity and movement latency.

The pendular tracking test was performed using ocular movement in the pursuit of a target that moved in a sinusoidal fashion. In this test, the velocity of stimulus presentation was 0.4 Hz in the horizontal plane. For this movement, the analysis was qualitative, since the equipment used did not allow for the analysis of parameters such as velocity and gain. Therefore, pendular tracking was classified as type I, type II, type III, or type IV⁽¹¹⁾.

At the end of the oculomotor tests, we conducted the optokinetic nystagmus test, which consists in an involuntary ocular movement before continuous visual stimuli. For this evaluation, we presented bright spots in a LED bar, which traveled in the same direction and velocity, clockwise and counter-clockwise in the horizontal plane. The studied velocity was 15°/s. The

parameters analyzed in this test were: measurement of the angular velocity of the slow component (AVSC) of the nystagmus obtained with a clockwise and anti-clockwise presentation of the bright stimulus and directional preponderance of nystagmus (DPN).

For this study, we took into consideration ametropia visual alterations, which are characterized by errors of refraction when the refracted rays in the eye do not converge in the retina. The most frequent ametropias are myopia, hyperopia, and astigmatism⁽¹²⁾. All participants with visual alterations used corrective lenses during the oculomotor tests.

For data analysis, we used nonparametric Mann-Whitney and Kruskal-Wallis tests. The significance level was set at 5% (p≤0.05).

RESULTS

We analyzed the oculomotor tests in 40 adults, divided into three groups according to age. Group 1 consisted of 16 participants (40%) aged 20 to 29 years, with a mean age of 21 years and 11 months, and including 5 males (31.25%) and 11 females (68.75%). Group 2, comprised 15 adults (37.5%) aged 30 to 39 years, with a mean age of 33 years and one month, and including 7 males (46.66%) and 8 females (53.33%). Finally, group 3 comprised 9 participants (22.5%) aged 40 to 49 years, with a mean age of 43 years and 9 months, all of whom were female (100%).

The presence of spontaneous nystagmus with eyes closed (SNEC) was observed in 7 participants (17.5%); of these, 2 had horizontal nystagmus to the right (28.58%) and 5 had horizontal nystagmus to the left (71.42%). The mean AVSC was 2,7143°/s, the maximum value was 5°/s, and the minimum value was 1°/s.

Initially, we studied the AVSC values of the optokinetic nystagmus to the right, optokinetic nystagmus to the left, and DPN for each group, as well as the comparison between them. According to the Kruskal-Wallis statistical test, no difference was observed between the three age groups (Table 1).

Table 1. Descriptive values and comparison between age groups in the angular velocity of the slow component (°/s) of the optokinetic nystagmus and the directional preponderance of nystagmus

	Optokinetic nystagmus AVSC (°/s)						DPN (%)		
	Right			Left			G1	G2	G3
	G1	G2	G3	G1	G2	G3			
n	16	15	9	16	15	9	16	15	9
Mean	10.68	11	10.11	10.81	10.6	9.4	6.31	5.93	7.88
Median	10	11	10	11.5	10	9	7	7	7
SD	3.07	1.96	1.61	2.95	2.29	1.42	4.61	3.88	4.88
Min value	7	7	7	6	8	8	0	0	0
Max value	18	14	13	16	15	12	14	11	16
p-value	0.483			0.379			0.669		

Kruskal-Wallis test (p<0.05)

Subtitle: AVSC = angular velocity of the slow component; DPN = directional preponderance of nystagmus; G1 = group 1; G2 = group 2; G3 = group 3; SD = standard deviation; Min Value = minimal value; Max Value = maximum value

Table 2. Descriptive values and comparison between the age groups in maximum velocity (°/s) and latency (ms) of the fixed and random saccadic movements

	Fixed saccadic movements						Random saccadic movements					
	Maximum Vel. (°/s)			Latency (ms)			Maximum Vel. (°/s)			Latency (ms)		
	G1	G2	G3	G1	G2	G3	G1	G2	G3	G1	G2	G3
n	16	15	9	16	15	9	16	15	9	16	15	9
Mean	379.8	357	442.2	71.75	102.6	57	447.5	426.4	371.7	123.6	130.6	185.7
Median	331.5	319	382	117	127	40	375	405	380	147	153	180
SD	167.8	129.7	189	219.7	184.1	172.0	169.1	83.5	37.31	159.8	167.3	39.1
Min value	182	182	166	-453	-293	-180	288	305	295	-453	-447	133
Max value	864	716	696	467	460	433	982	585	438	120	333	253
p-value	0.423			0.522			0.440			0.103		

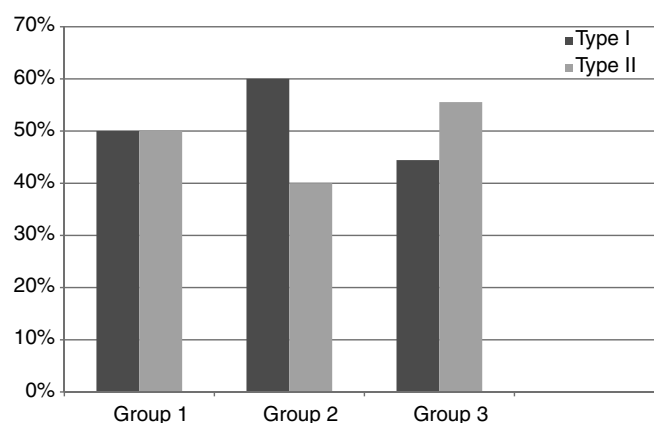
Kruskal-Wallis test ($p < 0.05$)**Subtitle:** Maximum Vel. = maximum velocity; G1 = group 1; G2 = group 2; G3 = group 3; SD = standard deviation; Min value = Minimum value; Max value = maximum value

Regarding fixed and random saccadic movements, we studied the maximum velocity (°/s) and latency (ms) for each group, as well as the comparison between groups. The Kruskal-Wallis statistical test showed no difference between groups (Table 2).

The slow eye movement in pursuit of a target was studied by means of pendular tracking. None of the participants presented type III or type IV tracking. We only observed the presence of type I and type II tracking, which had equal distribution in group 1. In group 2, we were able to verify a greater incidence of type I tracking (60%) and in group 3, we observed a predominance of type II tracking (55.5%) (Figure 1).

Since there were no differences in the values of oculomotor tests, optokinetic nystagmus, and saccadic movements between the three age groups studied, we decided to combine the samples to analyze the association between the presence of visual disorder (ametropias) and oculomotor tests (Tables 3 and 4).

Therefore, the sample was divided into two groups according to the presence or absence of visual alterations. The group without visual alterations was composed by 15 participants (37.5%) with a mean age of 29 years and 6 months. Those who had one or more visual alterations comprised the visual disorder

**Subtitle:** Type I = type I pendular tracking; Type II = type II pendular tracking**Figure 1.** Distribution of pendular tracking at a velocity of 0.4 Hz according to age group

group, which was composed of 25 participants (62.5%) with a mean age of 31 years and 11 months.

In the comparison of the AVSC of the optokinetic nystagmus to the right and to the left in individuals with and without visual alterations, the Mann-Whitney statistical test showed no difference between the groups. However, it showed differences

Table 3. Comparison of the angular velocity of the slow component (°/s) of the optokinetic nystagmus and the directional preponderance of nystagmus (%) according to the variable presence or absence of visual alteration

	Optokinetic nystagmus AVSC (°/s)				DPN (%)	
	Right		Left		No alteration	With alteration
	No alteration	With alteration	No alteration	With alteration		
n	15	25	15	25	15	25
Mean	11.13	10.4	11.13	10	4.66	7.64
Median	11	10	12	10	4	8
SD	2.35	2.39	2.94	1.93	4.28	4.10
Min value	7	7	7	6	0	0
Max value	14	18	16	14	12	16
p-value	0.079		0.131		0.034*	

*Significant value ($p \leq 0.05$) – Mann-Whitney test**Subtitle:** AVSC = angular velocity of the slow component; DPN = directional preponderance of nystagmus; SD = standard deviation; Min value = minimum value; Max value = maximum value

Table 4. Comparison of maximum velocity (°/s) and latency (ms) of the fixed and random saccadic movements according to the variable presence or absence of visual alteration

	Saccadic movements							
	Fixed				Random			
	Maximum velocity (°/s)		Latency (ms)		Maximum velocity (°/s)		Latency (ms)	
	No alteration	With alteration	No alteration	With alteration	No alteration	With alteration	No alteration	With alteration
n	15	25	15	25	15	25	15	25
Mean	416.8	364.6	59.53	92.32	488	237.82	91.06	169.76
Median	357	342	127	107	461	376	147	160
SD	175.24	148.91	182.73	201.18	163.90	62.01	226.23	39.64
Min value	261	166	-293	0	295	288	-453	133
Max value	864	686	300	433	982	560	333	240
p-value	0.404		0.826		0.004*		0.217	

*Significant value ($p \leq 0.05$) – Mann-Whitney test

Subtittle: SD = standard deviation; Min value = minimum value; Max value = maximum value

in the results of the DPN between the group that had visual alterations and the one that did not have them, observing a higher DPN in the group with visual alterations ($p=0.034$).

As regards the fixed saccadic movements in individuals with and without visual alterations, no difference was found in relation to the maximum velocity or latency of the movements. However, in the random saccadic movements, we verified that the maximum velocity was higher in individuals without visual alterations ($p=0.004$).

DISCUSSION

We observed that spontaneous nystagmus with eyes closed was present only in the horizontal direction, with a maximum AVSC of up to 5°/s in 17.5% of the sample; such data are in concordance with the literature, which shows that in normal individuals, the SNEC is equal to or lower than 6°/s⁽⁶⁾. A study conducted with 32 adults without vestibular disorders verified the presence of spontaneous nystagmus in ten participants (31.25%)⁽⁴⁾. Another study, also including adults without vestibular disorders, observed the presence of spontaneous nystagmus in five (12.5%) of 40 participants, including highest AVSC values of 6°/s⁽¹³⁾. The presence of SNEC may be related to the inability of the vestibular system in completely stabilizing the position of the eyes in the absence of visual support, which is deemed to be physiological⁽¹⁴⁾.

Regarding the direction of the nystagmus, a previous study⁽¹³⁾ has found that there was a predominance of horizontal nystagmus, present in four of the five participants, which also occurred in this study⁽¹³⁾. With the aim of assessing the influence of SNEC in other VENG tests in patients with chronic peripheral vestibulopathy, a national study also observed that the presence of SNEC was prevalent in the horizontal direction⁽¹⁵⁾. Of the seven patients with SNEC, five (71.42%) had horizontal nystagmus to the left and two (28.58%) to the right, which are results that differ from previous studies^(13,15). One of these studies⁽¹³⁾ verified the presence of SNEC in five of the

participants, four of whom had horizontal nystagmus to the right (80%), while the fifth participant (20%) had an oblique nystagmus to the right and upward.

In the optokinetic nystagmus test (Table 1), no difference was found in the AVSC values of nystagmus to the right and to the left and the DPN, when comparing the three age groups. The directional preponderance of nystagmus was 16%. These results were expected, since individuals without alterations present a symmetry of the results and the DPN of up to 16%⁽¹⁶⁾. A previous study conducted with individuals without alterations also found symmetry in the optokinetic nystagmus test⁽⁴⁾.

The age difference did not influence the parameters analyzed in the optokinetic nystagmus test, which differs from a study conducted in adults aged 22 to 82 years, which found that the velocity decreases as age increases⁽⁸⁾. However, we may infer that the age variation analyzed in this study was lower than that necessary to affect the analyzed parameter.

A detailed study of the optokinetic nystagmus test is important, since the alterations found included asymmetries between the sides of the nystagmus, or alterations in velocity and gain. These alterations indicate a central compromise, or may be present in vestibular dysfunctions^(5,17). Therefore, the findings in this test, during vestibular examination, may assist in the early diagnosis of possible central alterations.

Regarding saccadic movements (Table 2), we verified that the age factor did not affect the velocity of ocular movement, nor its latency. International research comparing the latency of young individuals (18 to 37 years of age) with those of individuals with advanced age (59 to 87 years of age) has observed that the latter had higher latency⁽¹⁸⁾.

Another study has shown the relationship of the latency of saccadic movements in relation to age. The sample comprised individuals aged 5 to 79 years and the results showed that individuals between the ages of 18 and 22 years had a shorter latency time in relation to younger and older subjects. The study also compared a group with individuals aged 20 to 40 years with a group of individuals aged 60 to 80 years and observed

that as age increases, movement latency becomes greater⁽¹⁹⁾.

In the same study, we carried out an analysis of the age of the patients in the same group and observed that the latency alteration in relation to age was higher in the group of individuals aged 60 to 80 years when compared with the variations in the group of individuals aged 20 to 40 years. This shows that, when groups with similar age variations are compared among themselves, the group with more advanced age has a greater alteration in relation to the latency of saccadic movements⁽¹⁹⁾.

A 2005 study showed that the latency of saccadic movements was also higher in children when compared with adults⁽³⁾. These data show the relevance of studies examining the influence of age in the various age groups, since reliable parameters of normality are essential during clinical assessments.

Still, regarding the analysis of the saccadic movement test, we were able to observe in the present study a large variation between the maximum and minimum values of the parameters of maximum velocity and latency in the same group. The variation in latency was also observed in a study performed in children, in which the authors attributed these findings to an attention deficit at the time of the test⁽³⁾.

In this study, our aim was not to compare the latency of fixed and random movements, but we observed (Table 2) that the maximum value of the latency of fixed movements was higher than that of random movements; this may be related to the velocity of the stimulus, which was higher in random movements (1 Hz), *i.e.*, when the stimulus is faster, the ocular movement must also be faster, requiring a shorter latency from the patient.

In the pendular tracking test (Figure 1), we performed a qualitative analysis, because the equipment software did not allow for a quantitative one. The research participants did not present type III or type IV tracking. According to the literature, type I and type II tracking are found in individuals without alterations, while type III tracking is found in individuals with peripheral or central vestibulopathy, and type IV tracking is found in patients with central alterations⁽¹¹⁾.

As noted, type I and II tracking had an equal distribution in group 1; however, in group 2 we were able to observe that the presence of type I tracking was greater than type II tracking, and in group 3, composed of individuals with a higher age range, there was a predominance of type II tracking (55.55%) over type I tracking. We may infer that individuals with a more advanced age have greater irregularity in tracking than younger individuals when performing a qualitative analysis. We found no studies analyzing the pendular tracking test qualitatively on the basis of age. However, a previous study with individuals without vestibular alterations aged 22 and 82 years has verified the influence of age on the test using a quantitative analysis, in which older individuals had a lower velocity during slow eye movements⁽⁸⁾.

Finally, we analyzed the effect of visual alterations in eye movements. We did not perform a separate analysis for each type of ametropia due to the small number of participants,

in addition to the fact that some of them had more than one alteration.

When performing the analysis of optokinetic movements in groups with and without visual alterations, we were able to observe that the AVSC showed no difference between the groups, *i.e.*, the visual alteration did not interfere with the movement. However, when analyzing the DPN between groups, we observed that it was higher in the group with visual alterations, *i.e.* individuals with visual alterations displayed a lower symmetry than those without visual alterations.

In the analysis of the fixed and random saccadic movement test, a difference between groups with and without visual alterations was only present for the maximum velocity parameter. In addition, we found that the average latency was shorter for the group without visual alteration (91.06 ms) than for the group with visual alteration (169.76 ms). We may infer that individuals without visual alterations presented a higher saccadic movement velocity, with a shorter latency when the stimulus was not predictable, suggesting a better oculomotor movement.

Based on the results of the study, we observed that even without changing the normality standard there are differences between individuals with and without visual alterations, even with the correction of these alterations through corrective lenses. This fact emphasizes the importance of studies analyzing the effect of visual alterations on oculomotor tests, with and without the use of corrective lenses, allowing for the definition of normal standards in relation to these variables and contributing to the assessments that do not allow for the use of corrective lenses, as in the case of videonystagmography.

This study is aligned with the literature on the importance of oculomotor movement assessment through computerized vectoelectronystagmography as it has a greater sensitivity in the detection of oculomotor alterations that may suggest central disorders^(6,20). With the various analyses that may be performed by VENG, it is necessary that more studies be carried out in order to establish normal parameters with respect to age variation, presence of visual alterations, as well as the analysis of the behavior of the oculomotor system before the variation of velocity and stimuli, increasing at each time the sensitivity of the assessment.

It is essential for professionals who perform vestibular tests to know the parameters of normality. Nonetheless, these parameters may be influenced by some factors, such as age, visual alterations, and stimulus velocity. Therefore, the professional should be attentive to the disorders that these factors may cause, so that they may interpret test results correctly and not only regarding the normality values, which may also vary between equipment.

CONCLUSION

Oculomotor tests were not influenced by the age factor in the age range studied; however, the presence of visual disorders

influenced a few parameters of the oculomotor tests. In the optokinetic nystagmus test, the DPN was higher in individuals with alterations. In the saccadic movement test, individuals without visual alterations displayed a higher maximum velocity.

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