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Comparative characteristics of changes in visual acuity according to test lighting in healthy people and in patients with myopia

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ABSTRACT

The objective of the work consisted of comparing the characteristics of the changes in visual acuity as a function of the illumination of the tests in healthy individuals and in patients with myopia, examining two groups (50 people each): a control group of healthy individuals and patients with high myopia with visual acuity with optimal correction above 1.0. Visual acuity was determined under different lighting conditions (from 50Lx to 400Lx) using optotype tables with a small step of 0.05, and increasing the function δ, which is the difference between these values. δ in healthy individuals is 0.7, and in individuals with myopia it is equal to 0.55, which is a fairly high indicator and confirms the absence of contraindications to attract this category of patients to various types of visually strenuous work, including driving.

KEY WORDS: lighting; myopia; visual acuity.

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Características comparativas de los cambios en la agudeza visual según la iluminación de la prueba en personas sanas y en pacientes con miopía

RESUMEN

El objetivo del trabajo consistió en comparar las característica de los cambios en la agudeza visual en función de la iluminación de las pruebas en individuos sanos y en pacientes con miopía, examinando dos grupos (50 personas cada uno): un grupo control de individuos sanos y pacientes con miopía alta con agudeza visual con corrección óptima por encima de 1, 0. La agudeza visual se determinó en condiciones de iluminación diferente (de 50Lx a 400Lx) utilizando tablas de optotipos con un pequeño paso de 0.05, y el incremento de la función δ, que es la diferencia entre estos valores. δ en individuos sanos es 0.7, y en individuos con miopía es igual a 0.55, que es un indicador bastante alto y confirma la ausencia de contraindicaciones para atraer a esta categoría de pacientes a varios tipos de trabajos visualmente extenuantes, incluso al conducir.

PALABRAS CLAVE: iluminación; miopía; agudeza visual.

Introduction

For several decades, myopia remains one of the urgent problems of ophthalmopathology (Avetisov et al., 2020; Avetisov, 2002; Hayashi et al., 2006; Horgan et al., 2005; Nishi et al., 2008). This is due to both the high prevalence of the disease (up to 45% of children and 25% of the adult population) and the disabling consequences of complicated myopia (1st or 2nd place among the causes of disability) (Avdeeva et al., 2018; Proskurina and Tarutta, 2020; Tarutta et al., 2020; Pucci et al., 2001; Zhukova and Smirnitskaya, 2014). Myopia can lead to severe irreversible processes and permanent disability. People with myopia are often limited in their choice of specialty, and the detection of myopia at the professional examination of drivers of vehicles may serve as a reason for rejection of hiring.

In the onset of myopia, both genetic factors and environmental factors play a role, such as illumination in the room for work, illumination of the workplace, illumination of the surrounding field, etc. Failure to comply with certain rules can lead already in the early stages to degenerative-dystrophic processes, damage the scotopic apparatus of the retina, followed by the involvement of photopic structures, expressed in a decrease in distance

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visual acuity and impaired twilight vision. As the disease progresses, light adaptation also decreases, color vision is impaired, and central and paracentralscotomas appear (Aller, 2014; Aller and Wildsoet, 2013; Hayashi, Yoshida and Hayashi, 2006; Holden et al., 2014; Proskurina and Tarutta, 2020; Tarutta et al., 2012; Tarutta et al., 2015; Tarutta et al., 2020). Therefore, it seems to us especially important to study visual acuity depending on the illumination of the tests (OT) in persons suffering from myopia.

The purpose of our work was to carry out a comparative characteristic of changes in visual acuity depending on the illumination of tests in healthy individuals and in patients with myopia.

1. Material and research methods

Since in our country the requirements for admission when driving a car are one of the most stringent in the world, this category of workers was selected for examining healthy persons. The peculiarity of this study is that it was first conducted in Kabardino-Balkar Republic (the authors did not find analogs of this study in the available published literature). We examined 50 healthy drivers (control group A) of the transport company No. 1 in the city of Nalchik, which has its own modern, well-equipped polyclinic. All the studied patients signed the form of informed consent for the participation in the study. The main condition for the selection was the absence of road accidents among drivers of vehicles during its work. Accident data were taken from individual driver cards that were held by the HR department. Another condition is that they are somatically healthy people who do not complain about the general condition of the body and the organ of vision in particular. Drivers worked on GAZ 24-10 and RAF vehicles (belonging to categories B and D according to the International classification) on urban routes with a regular load during a 12-hour work shift according to a shift schedule (1 shift - from 6 to 18 hours, 2 shift - from 18 to 6 o'clock). Corrected visual acuity in all the subjects was at least 1.0, the intraocular pressure, visual field, and color perception were normal.

Group A1 was formed from patients of the same age (50 people) to compare the obtained data with similar results of the corresponding age. Group A1 included patients with high myopia, and their visual acuity with optimal correction should have been higher than 1.0. The study of visual functions included not only a study using generally accepted

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methods (visual acuity, refraction, tonometry, etc.), but also more subtle ophthalmoergonomic tests (accommodation, CFFF, visual productivity, etc.) or exceeded them, were admitted to further research.

All surveyed were men aged 20 to 55 years (average age - 37.08 10.19) with work experience from 3 to 30 years (average 17.73 6.06).

The study of visual acuity was carried out in 2 stages. First, visual acuity is determined with standard illumination, and then a study was carried out with a decrease in illumination from a minimum of 50 Lx to a maximum of 400 Lx. The range of illumination was chosen taking into account the fact that an increase in the illumination of optotypes above 400 Lx and below 50 Lx does not reveal a significant change in visual acuity (Tlupova et al., 2006).

The purpose of the experiment is to determine the magnitude of the increment of the function **δ**, which is the difference between these values. It is necessary to compare the obtained value of the increment of the function **δ** with the norm established by us and, if a decrease in this indicator is detected, to raise the question of admission to driving. The second stage of the study is the most important, because even in healthy people who do not complain about the general health of the body and the organ of vision, in particular, a decrease in visual acuity is possible when the light conditions deteriorate, which is dangerous for driving at twilight and at night.

A device for determining visual acuity (RF Patent No. 2269921) (Tlupova et al., 2006), which makes it possible to determine visual acuity in conditions of different illumination using tables of optotypes with a small 0.05 step, is used for research. This makes it possible to predict the development of various emergency situations by drivers, whose visual acuity at the first stage of the study was quite high and was not a contraindication to admission to driving.

2. Results and discussion

Our results are presented in the table. A statistically significant difference in changes in visual acuity in normal conditions and in myopia, depending on the illumination of the tests, was established. The coefficient of reliability is less than 1.96 when the illumination of the tests is equal to 200 lux. Probably, the given illumination is equally optimal for the

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study of these categories.

Table 1. Changes in visual acuity with changes in test illumination in healthy individuals and with myopia

Illumination (Lx)	Visualacuity				
	Group A	Group Al			
	M	**±σ**	**M**	**±σ**	t
50	1,13	0,18	1,05	0,24	1,46
100	1,42	0,22	1,17	0,32	3,52
150	1,52	0,21	1,25	0,36	3,54
200	1,62	0,24	1,32	0,28	1,70
250	1,64	0,27	1,44	0,24	2,72
300	1,81	0,26	1,48	0,26	4,91
350	1,83	0,22	1,52	0,32	4,37
400	1,83	0,24	1,56	0,24	4,35
Morethan 400	1,83	0,24	1,6	0,32	3,14
δ	0,70		0,55		

M is the arithmetic mean, s the standard deviation, **t** s the reliability of the difference, **δ**is the increment of the function reflecting the difference in visual acuity at a maximum of 400 Lx and a minimum of 50 Lx of illumination

It was determined that with an increase in the illumination of the tests from 50 to 400 Lx, the visual acuity of healthy persons increases by 0.70 (from 1.13 ± 0.18 to 1.83 ± 0.24), while in myopia the magnitude of the increase in acuity vision is 0.55 (from 1.05 ± 0.24 to 1.6 ± 0.32). The increase in visual acuity is more clearly seen in the figure.

Thus, it is possible to predict the magnitude of visual acuity by changing the illumination of the tests and assume that if the subject has a visual acuity with optimal correction equal to 0.4 at the illumination of the tests = 50 Lx, then with the illumination of the tests = 400 Lx this value will be equal to 0.9-0.95; with a visual acuity of 0.1 (test illumination = 50 Lx) -0.5. That is, the increment of the function **δ** for this category of patients is determined and it is equal to 0.55. This can be used in the definition of aggravation and simulation of persons sent for medical and social expertise.

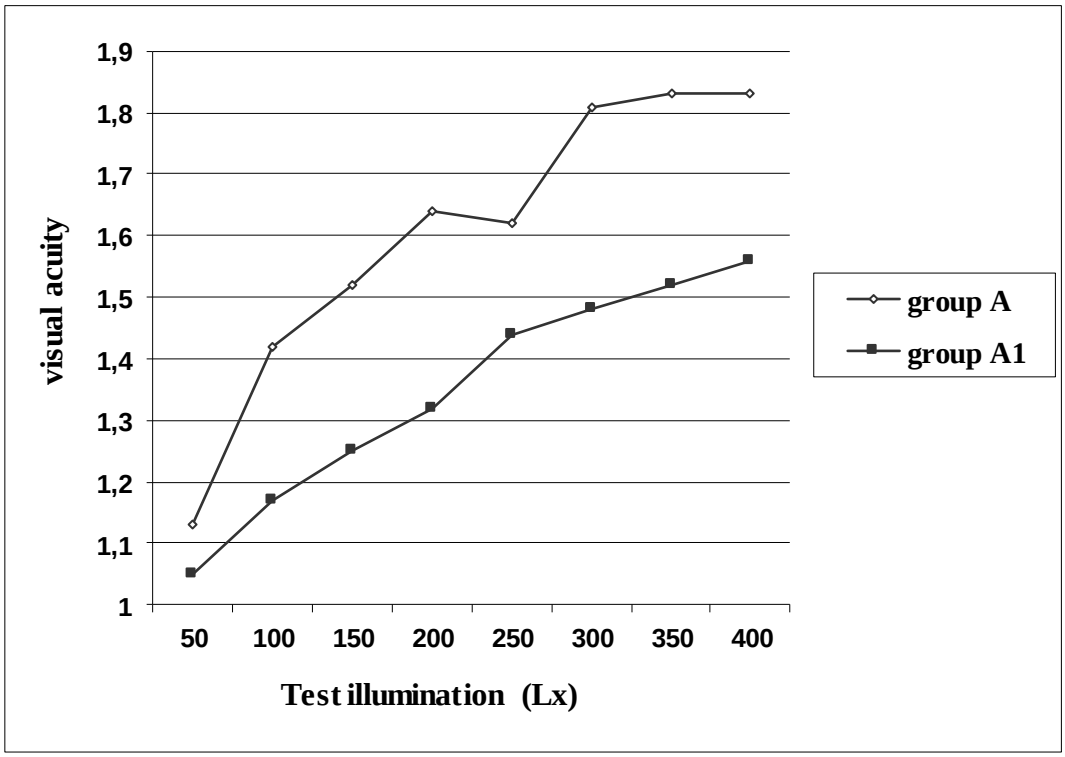

Figure 1. Changes in visual acuity with changes in test illumination in healthy individuals and with myopia

Despite the significant difference in the values obtained, it should be noted that the visual acuity of myopes is quite high, which confirms the absence of contraindications to attracting this category of patients to various types of visually-intense work, including when driving.

Conclusion

A statistically significant difference in changes in visual acuity in normal conditions and in myopia, depending on the illumination of the tests, was established, but the visual acuity of patients with myopia is quite high; this confirms the absence of contraindications to the attraction of this category of patients to various types of visually strenuous work, including when driving.

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