



THE INFLUENCE OF STRABISMUS ANGLE SIZE ON THE STATE OF STEREOSCOPIC VISUAL ACUITY

UTICAJ VELIČINE UGLA STRABIZMA NA STANJE STEREOSKOPSKE VIDNE OŠTRINE

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ABSTRACT

The aim of the research is to examine the influence of the size of the strabismus angle on the state of stereoscopic visual acuity. The study included 240 participants, aged from 3 to 18 years, all examined in the orthoptic-pleoptic unit of the Eye Disease Clinic at the University Clinical Center Tuzla. The participants were divided into three age subgroups: 3 to 6 years, 7 to 14 years, and 15 to 18 years. The participants were equalized by number, age, and sex. For data analysis, the software package SPSS 17.0 for Windows was used, applying descriptive statistics, the Mann–Whitney test, p-value, and the χ^2 test. After data processing, and considering the results obtained through the research, it can be concluded that the size of the strabismus angle influences the state of stereoscopic visual acuity, with statistical significance recorded in all examined age groups. The research results indicate the importance of timely treatment, as well as the need for early detection, that is, early systematic examinations of preschool-aged children and the prevention of amblyopia.

Key words: stereoscopic visual acuity, size of strabismus angle, amblyopic children.

SAŽETAK

Cilj istraživanja je ispitati uticaj veličine ugla strabizma na stanje stereoskopske oštrine vida . Istraživanjem je obuhvaćeno 240 ispitanika, životna dob ispitanika se kretala od 3 do 18 godina života, svi su pregledani u ortoptičko-pleoptičkom kabinetu Klinike za očne bolesti UKC-a Tuzla. Ispitanici su podijeljeni u tri dobne podskupine od 3 do 6 godina starosti, te od 7 do 14 godina i dobna skupina od 15 do 18 godina starosti. Ispitanici su izjednačeni po broju ispitanika, dobi i spolu. Za obradu podataka korišten je programski paket SPSS 17.0 for Windows gdje je primijenjena deskriptivna statistika, Mann Whitney test, p-vrijednost, χ^2 test.

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Nakon obrade podataka, uzimajući u obzir rezultate do kojih se došlo istraživanjem, može se zaključiti da na stanje stereoskopske oštine vida utiče veličina ugla starabizma, gdje je zabilježena statistička značajnost kod svih ispitivanih dobnih skupina. Rezultati istraživanja ukazuju na značaj blagovremenog tretmana, te potrebu za ranom detekcijom, odnosno, ranim sistematskim pregledima djece predškolske dobi i prevencijom slabovidnosti.

Ključne riječi: stereoskopska vidna oština, veličina ugla strabizma, slabovidna djeca.

INTRODUCTION

More than 80% of information from the external world is received through vision, which indicates its fundamental role in everyday functioning (Atkinson, 2021). The development of binocular vision represents a process of integrating visual information from both eyes in order to form a single image with stereopsis (Tychsen, 2020). Normal binocular cooperation requires a common direction of the visual axes of both fovea centralis (Johnson et al., 2002). Binocular vision is enabled by the proper function of the extraocular muscles and conditioned by sensory correspondence of both retinas. Disorders of binocular viewing are often associated with dysfunction of the visual centers in the cerebral cortex, due to the specific influx of visual information, which is also related to difficulties in the maturation of the visual pathway. This insufficiency negatively affects visual acuity, eye movements, fixation, convergence, and stereovision (Huang et al., 2009). One of the common disorders of binocular vision is strabismus. Strabismus occurs when it is impossible to simultaneously direct both lines of sight toward the fixation point. Strabismus is an anomaly of eye position and a disorder of binocular visual function. Heterotropia represents a manifest deviation of the eyes from their normal parallel position (Dorn and Petrinović-Dorešić, 2008). Binocular diplopia is double vision that occurs as a result of strabismus (Taub, 2008). Strabismus occurs when it is impossible to simultaneously direct both lines of sight toward the fixation point (Larson et al., 2003). Strabismus is an anomaly of eye position and a disorder of binocular visual function. Its characteristics include motor anomalies or non-parallelism of the visual axes. The motor anomaly very quickly causes sensory disturbances. Underlying causes include neurophysiological dysfunctions of higher brain structures as well as refractive anomalies (Lakoš-Krželj, 2004). The treatment of visual disorders such as strabismus and diplopia is a key factor for binocular vision (Zhang et al., 2007). Stereoscopic acuity is an indication of binocularity. Persons with strabismus do not have stereoscopic visual acuity (Meier et al., 2014). Many persons without stereovision have (or have had) visible strabismus (Bradley et al., 2014). The lack of stereovision may be complete or impaired more or less. Its causes most commonly include: blindness in one eye, amblyopia, and strabismus (Xi et al., 2014). Reduced stereoscopic visual acuity is often associated with reduced visual acuity and strabismus, that is, amblyopia (Dorn and Petrinović-Dorešić, 2007). Early strabismus has a negative effect on the development of stereovision, and infantile esotropia as an eye-position deviation affects the development of stereovision at the earliest age, that is, in the first 6 months of life (Read, 2015). Proper treatment of ocular motility disorders in early childhood significantly reduces the risk of permanent loss of binocular vision (Kim et al., 2021).

RESEARCH AIM

To examine the influence of the size of the strabismus angle on the state of stereoscopic visual acuity.

RESEARCH METHODS

Sample of participants

The sample of participants consisted of amblyopic children with varying degrees of amblyopia (mild, moderate, and severe forms). A total of 240 participants were examined (N=240), aged 3 to 18 years, who were examined in the orthoptic-pleoptic unit of the Eye Disease Clinic at UKC Tuzla. The participants were divided into three age groups: the age group from 3 to 6 years, the age group from 7 to 14 years, and the age group from 15 to 18 years. The participants were equalized by number, age, and sex. The criteria participants had to meet in order to be included in the sample of this research were: having visual impairment, having preserved intellectual status, and being chronologically between 3 and 18 years of age.

Sample of variables

The variables used in this research can be divided into two groups: anamnestic variables and variables for examining the function of stereoscopic visual acuity.

Method of conducting the research and measurement instruments

The research was conducted in the Orthoptic and Pleoptic Unit of the Eye Disease Clinic at UKC Tuzla, based on the implementation of clinical tests designed to detect stereovision dysfunction. Within the research, the following methods were used: anamnesis, visual acuity examination, refraction (subjective and objective method), examination of eye motility and oculomotor balance of the external eye muscles (duction and version in nine gaze directions), the cover–uncover test, examination of convergence, measurement of objective deviation (Synoptophore with mandatory alternating occlusion before measuring the angle), methods of measuring the objective angle using a prism and the cover test, examination of retinal correspondence and binocular vision: on the synoptophore, Filter-Rossi-Bagolini, Worth test, Titmus test, Lang stereo test (Lang I and Lang II), Bar-Reading test.

Statistical data processing

For the observed variables at each examination, for each group of participants formed according to age, absolute and relative frequencies were calculated, as well as measures of central tendency and measures of dispersion. To test the existence of differences in mean values between groups of participants formed according to specific criteria, nonparametric tests were used, since the observed characteristics were nominal and the numerical characteristics did not follow a normal distribution, which was determined by the Kolmogorov-Smirnov test. To determine the interdependence between the modalities of qualitative variables, contingency tables and the chi-square test of interdependence were used. To determine the existence of differences in mean values between two independent samples, the nonparametric Mann–Whitney test was used, while for determining differences in mean values between three independent samples, the nonparametric Kruskal–Wallis test was used.

For data processing, the software package SPSS 20.0 was used. All tests were conducted at a significance level of 5% (0.05).

RESULTS AND DISCUSSION

Table 1 shows the data on the number and structure of participants with respect to sex and type of visual impairment. By examining the table, we can see that of the total number of participants, 72.95% of males and 76.27% of females have strabismic amblyopia. Refractive amblyopia was present in 15.57% of males and 7.63% of females. Anisometropic amblyopia was present in 7.38% of male participants and 5.93% of female participants. Visual-deprivation amblyopia was more common in females (6.78%) than in males (3.28%). Also, organic amblyopia was more common in females (3.39%) than in males (0.82%). Based on the obtained results, in the total number of participants, as well as in both male and female participants, strabismic amblyopia was the most prevalent.

Table 1. Number and structure of participants according to sex and type of visual impairment

TYPE OF AMBLYOPIA	SEX OF PARTICIPANTS					
	Male		Female		Total	
	f	%	F	%	f	%
Visual-deprivation	4	3.28	8	6.78	12	5.00
Organic	1	0.82	4	3.39	5	2.08
Anisometropic	9	7.38	7	5.93	16	6.67
Ametropic/Refractive	19	15.57	9	7.63	28	11.67
Strabismic	89	72.95	90	76.27	179	74.58
TOTAL	122	100.00	118	100.00	240	100.00

By examining the results in Table 2, it can be seen that strabismic amblyopia was the most prevalent among all participants, so that in children aged 15 to 18 years it amounted to as much as 82.28%, in children aged 7 to 14 years it was 74.07%, and in children aged 3 to 6 years it amounted to 67.50%. Looking at the total number of participants in general, 74.58% of them had strabismic amblyopia. The next most prevalent was refractive amblyopia, and it was most common in children aged 3 to 6 years with a percentage of 15.00%, while in children aged 7 to 14 years it was present in 11.11%, and its prevalence was somewhat lower in children aged 15 to 18 years, amounting to 8.86%. Anisometropic amblyopia was most prevalent in children aged 7 to 14 years with 11.11%, then in children aged 15 to 18 years with a percentage of 5.06%, while it was present in children aged 3 to 6 years with a percentage of 3.75%. Visual-deprivation amblyopia was most prevalent in children aged 3 to 6 years with a percentage of 8.75%, then in children aged 7 to 14 years it amounted to 3.70%, while it was the least prevalent in children aged 15 to 18 years with 2.53%. Considering the age level of the participants, we can see that organic amblyopia was most prevalent in children aged 3 to 6 years with a percentage of 5.00%, then in children aged 15 to 18 years

with a percentage of 1.27%, while organic amblyopia was not present in children aged 7 to 14 years.

Table 2. Number and structure of participants according to type of visual impairment and age

TYPE OF AMBLYOPIA	AGE OF PARTICIPANTS							
	3-6 yrs		7-14 yrs		15-18 yrs		Total	
	F	%	f	%	f	%	f	%
Visual-deprivation	7	8.75	3	3.70	2	2.53	12	5.00
Organic	4	5.00	0	0.00	1	1.27	5	2.08
Anisometropic	3	3.75	9	11.11	4	5.06	16	6.67
Ametropic/Refractive	12	15.00	9	11.11	7	8.86	28	11.67
Strabismic	54	67.50	60	74.07	65	82.28	179	74.58
TOTAL	80	100	81	100	79	100	240	100

In Table 3, the research results presented relate to determining the existence of the influence of the strabismus angle size on stereoscopic visual acuity in children of different age levels. Here we can see that the presence of stereovision was recorded in children who had a deviation angle of 10 degrees, amounting to 33.33%. In children who had a deviation angle of 11–20 degrees, the presence of stereovision was recorded in 56.25% of them. Children with a deviation angle of 21–30 degrees had stereovision present in only 10.42%, and children whose deviation angle was 30 degrees or more did not have stereovision present at all. Thus, we see that the absence of stereovision is greatest in children with a deviation angle of 21–30 degrees, where the absence of stereovision was recorded at 47.92%. A high percentage of absence of stereovision was also present in children with a deviation angle of 11–20 degrees, amounting to 28.47%, and with a deviation angle of 10 degrees the absence of stereovision was recorded in 18.75%. Similar results were obtained by Regoda (2013), who emphasized that the size of ocular deviation significantly affects the obtained results of stereoscopic visual acuity, indicating impairment of stereovision. Also, in the study by Caputo et al. (2007), children with strabismus performed worse on fine motor tasks than their peers without strabismus. Conducted research notes improvement in motor skills in 35% of children after strabismus surgery, which indicates the connection between stereovision and motor skills. Visually guided reaching and grasping also improved in 41% of children after strabismus surgery (Birch and Wang, 2009). According to the obtained results, a higher percentage of children who have stereovision present is found in the subgroup of children with a deviation angle of up to 10 degrees (33.33%) and in the subgroup with a deviation angle between 11 and 20 degrees (56.25%). In contrast, a higher relative share of children who do not have stereovision present is found in the subgroups of children with a deviation angle between 21

and 30 degrees (47.92%) and with a deviation angle of more than 30 degrees (4.86%). According to the results of the chi-square test and its corresponding p-value ($p < 0.05$), it can be concluded that there is a statistically significant difference between the size of the strabismus angle and stereoscopic visual acuity.

Table 3. Differences in influence of strabismus angle size on stereoscopic visual acuity

Strabismus angle	STEREOVISION					
	Does not exist		Exists		Total	
	f	%	f	%	f	%
Up to 10	27	18.75	32	33.33	59	24.58
11-20	41	28.47	54	56.25	95	39.58
21-30	69	47.92	10	10.42	79	32.92
31 and over	7	4.86	0	0.00	7	2.92
TOTAL	144	100.00	96	100.00	240	100.00

$\chi^2=45.485$; $df=3$; $P=0.000$

CONCLUSION

Based on the results of the conducted research, we can see that there is a statistically significant difference between the size of the strabismus angle and stereoscopic visual acuity in all participants. In cases of early diagnosis of the absence of stereovision, children should be included in rehabilitation programmes. Based on the obtained results, we can conclude the importance of timely prevention, detection, and rehabilitation. The research results also indicate the significance of timely treatment and the need for early detection, that is, early systematic examinations of preschool children and the prevention of strabismus, which at the same time points to the need for greater involvement of special education teachers—typhlologists in the work of healthcare, as well as preschool and school institutions.

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