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DIFFERENCES IN VISUAL ACUITY OF THE RIGHT AND THE LEFT EYE AND STRABISMUS ANGLE ACCORDING TO THE AGE IN INITIAL OVERVIEW, IMMEDIATELY AFTER THE SURGERY AND ONE YEAR AFTER THE SURGERY

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Abstract

Vision has an enormous importance for live and work of a human being and thus eye impairment takes a special place, too. A child with poor sight has difficulties with learning, and strabismus as an esthetic deficiency affects his/her mood, he/she is reclusive, depressed and lacks self-confidence. The purpose of research is to examine functionality of binocular vision postoperatively in case of esotropia, and check visual acuity of both eyes, strabismus angle size, age and their influence on strengthening binocular vision postoperatively in case of esotropia. The research included 58 examinees with esotropia who underwent a surgery. The data used for this research were collected on the basis of information from history of diseases of the examinees cured at the Cabinet for orthoptics and pleoptics of the Clinic for ophthalmology, University Clinical Center Tuzla. The examinees were from 3 to 14 years old. The research included three periods of observation: the first – initial examination, period after the surgery and one year after the surgery. The examinees were divided into two age groups: from 3 to 6 and from 7 to 14. The examined variables are: age, visual acuity of the right and left eye, strabismus angle size, binocular vision. Within research, the following methods were applied: analysis of medical documentation, examination of visual acuity, refraction, examination of motility of eye and oculomotor balance of eye muscles, cover and uncover of eye (cover-uncover test), measuring objective deviation, i.e. objective angle of strabismus (on synoptophore with obligatory alternating occlusion prior to angle measuring), binocular vision test (on synoptophore). Upon data processing, the results obtained from the research show that there are differences in average values of visual acuity of the right and left eye among age groups of examinees from 3 to 6 and from 7 to 14 in initial examination, immediately after the surgery and one year after the surgery. It can be concluded that better results have been achieved at younger age group, from 3 to 6, in the sense of improvement of visual acuity, decrease of strabismus angle. A surgery at appropriate age determines favorable conditions for achieving and strengthening binocular cooperation, i.e. its functional improvement. Results of achievement also point to the importance of prompt treatment and to the need for early detection, i.e. early systematic examinations of pre-school children and prevention of strabismus and amblyopia, which at the same time points out the need for more serious inclusion of a defectologist - typhlogist in operation of health, pre-school and school institutions.

Keywords: Esotropia, Age, Visual Acuity, Strabismus Angle Size, Amblyopia, Binocular Eyesight.

INTRODUCTION

Vision has an enormous importance for live and work of a human being and thus eye impairment takes a special place, too. The fact that it is through the eye that we receive about 90% of all impressions from outer world, while 10% belongs to other sensory organs, speaks enough for its importance. A child with poor sight has difficulties with learning, and strabismus as an esthetic deficiency affects his/her mood, he/she is reclusive, depressed and lacks self-confidence (Deftadarević-Serdarević, 1996). Vision at human beings and higher vertebra is the most important sensory for observation of environment, space and behaving in those. Vision and hearing are the greatest sensory of environment and distance observation.

Visual ability for observance of distance, orientation in space and recognition of details of objects have not been surpassed by either of sensory. Furthermore, visual system creates a very clear and profound image of space (Čelić, Dorn, 2004). Cognition of normal visual functions of children from the earliest age to the adolescence is constantly amended and modified. In order to better understand the reasons of

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appearance of vision disturbance it is first necessary to have knowledge about a normal development of vision. Recent knowledge about embryology, histology and anatomy of eye, new types of examinations and possibilities of examination of eye and its acuity ever since the first days of life significantly contribute to the intention of prompt detection of oculomotor disturbance, disturbance of object fixation as well as prompt detection of changes on the eye bottom, whereby it is easier to discover whether the child's eye function is normal (Čupak, Čupak-Zergollern, 1997). In case of possible vision impairment, one should act preventively prenatally, at birth, in childhood and at adult age, i.e. at pre-school and school institutions as well as at working environment (Čupak, 1990). Hearing and perceptive capacities refer to capacities for reception and interpretation of information from the environment or proper body. Visual capacities in the narrow sense often relate to the perception of light, colors and shapes. It can be also said that they include: perception of light; central, peripheral, binocular, spatial and color vision. In the wider sense, visual capacities are significantly more comprehensive. Visual functions can be quantitative and qualitative. The basic quantitative function of the eye is perception of the light. Qualitative functions are: central, peripheral, spatial, adaptive, binocular and color vision. The basic function of the eye is perception of the light. All the other functions are: central acuity of vision, peripheral vision or field of vision, capacity of differentiation among colors or color vision, i.e. capacity of seeing in the dark or adaptation to the dark and binocular vision, i.e. capacity of perception of the third dimension – stereoscopic vision have their basis in perception of the light (Smiljanić, 2001). Good vision acuity is crucial for normal physical and psychical development of children. Reception of equal information by vision on both eyes is essential for development of visual center in brain (Lee, Lee, Kim, 2001). Visual acuity represents a measure of quality of the central vision. It is a measure of capacity of the eye to clearly differentiate fine details of the observed object at certain distance (Mitrović, Stefanović, 1990). Visual acuity is capacity to distinguish details in space, i.e. clarity or brightness of vision (Ohlsson, 2003). If visual acuity in one eye is normal (visus 1,0), visual acuity in the other eye should be at least 0,3 in order to achieve normal development of binocular function (Smiljanić, 2001). The knowledge of real visual acuity at children in development and early childhood is very important, but comparison of visual acuity of one eye in respect to the other eye is more interesting and more practical for an ophthalmologist (Stankov, Ljutica, 2005) Vision impairment as a cause of amblyopia is accompanied by strabismus. These children have serious deficiencies in fixation of vision, evaluation of depth of space, following object in movement. Disorders in motor mobility of their eyes shall have a direct impact on spatial analysis and synthesis (Golubović, 2005). If a parallelism of vision axes can be gained and preserved without a surgery, as in case of accommodation esotropia, then it is necessary to perform a surgery. Esthetic vision and position of a pupil are improved by surgeries on bulbomotors (Lakoš-Krželj, 2004). After the surgery, new motor and anatomic conditions are created, which change the previously established sensory qualities. This is why, in postoperative period, it is necessary to strengthen desired sensory qualities by ortho-pleoptic methods and not allow creation of new anomalies, including amblyopia and double images (Helveston, 1993).

PURPOSE OF RESEARCH

Examine functionality of binocular vision considering visual acuity of the right and the left eye, strabismus angle size and age of examinees.

METHOD OF OPERATION

Sample of examinees

The research includes 58 examinees, 30 females and 28 males. They are 3 to 14 years old.

In order to determine at what age a surgery and orthoptic pleoptic exercises provide best conditions for reaching binocular eyesight, examinees were divided into two age groups: 3-6 year olds and 7-14 year olds. Amblyopia (poor eyesight), as accompanying phenomenon, was present at 36 examinees, while 22 of them were without amblyopia.

Sample of variables:

The research includes examination of multiple perception of characteristics. The examined independent variables are: age, eyesight acuity on the right and left eye, strabismus angle size, and amblyopia, while dependent variable is a binocular vision.

Mode of research conduction and instruments of measurement

Data used for this research were gathered on the basis of history of patients processed and treated at Department for orthoptic and pleoptic, Clinic for eye diseases, UCC Tuzla.

Criteria for data processing were examinees with esotropia (convergent strabismus), who were performed a surgery. The research was conducted in three periods of observation: the first (initial) examination, immediately after surgery and a year after surgery, including orthoptic pleoptic exercises. The following methods were used within the research: analysis of medical documentation, examination of eyesight acuity, refraction, examination of eye motility and oculomotor balance of eye muscle, cover-uncover test, measurement of objective deviation, i.e. of objective angle of strabismus (on synaptophore with obliged altering occlusion before measuring the angle), examination of binocular vision (on synaptophore).

Data processing methods

SS 17,0 for Windows program package SP was used for data processing.

For observed variables at each examination, for every group of examinees established according to their age, measures of central tendency, measures of dispersion and quartiles were calculated. To test presence difference of middle values among the groups established according to the age of patients (independent samples), and according to other criteria, analysis of variance (ANOVA), i.e. p-value, was applied. To see whether there is a statistically significant connection (interdependence) among some variables, a dependence test, i.e. Chi-square test was applied.

RESULTS

The results reached after examination of the variables visual acuity of the right eye, visual acuity of the left eye and strabismus angle, for the age group 3 to 6 depending on which examination it is about, i.e. about the period of examinations are shown in table 1. According to the results presented in table 1, the calculated (empiric) p-value is less than 0,05 (5%) of the level of importance on which the testing was performed, at variables left eye visual acuity and strabismus angle, which refers to the conclusion that there is a statistically significant difference in average value of the mentioned variables between the examinations. At variable right eye visual acuity the p-value is higher than 0,05, thus in case of this variable there is no statistically important difference between examinations. Thus, at variable left eye visual acuity, a higher average value was registered one year after the surgery, while, on the other hand, one year after the surgery less average value of strabismus angle was registered.

Table 1. differences in the age group 3-6 years

	The first review	After surgery	One year after surgery	In total	df1	df2	F	p
	$\mu \pm \sigma$	$\mu \pm \sigma$	$\mu \pm \sigma$	$\mu \pm \sigma$				
Visual acuity of the right eye	0,61 ± 0,33	0,63 ± 0,32	0,76 ± 0,28	0,67 ± 0,31	2	114	2,514	0,085
Visual acuity of the left eye	0,59 ± 0,33	0,60 ± 0,32	0,75 ± 0,30	0,64 ± 0,32	2	114	3,100	0,049
The angle of strabismus	26,28 ± 5,59	10,15 ± 5,13	11,33 ± 5,69	15,92 ± 9,15	2	114	105,274	0,000

Hereinafter, the table 2 shows results reached by research of variables right eye visual acuity, left eye visual acuity and strabismus angle, for the other age group from 7 to 14, depending on which examination it is about, i.e. about the period of examinations. According to the results presented in table 2, the calculated (empiric) p-value is less than 0,05 (5%) of the level of importance on which the testing was performed, at variables strabismus angle, which refers to the conclusion that there is a statistically significant difference in average value of the mentioned variable at initial examination, immediately after the surgery and one year after the surgery. At variables right eye visual acuity and left eye visual acuity the p-value is higher than 0,05, thus in case of these variables there is no statistically important difference between examinations. Thus, at variable strabismus angle, less average value was registered one year after the surgery. At age group from 7 to 14 there was no significant improvement of visual acuity of the right and the left eye, while strabismus angle was reduced as a result of the surgery. Taking into consideration results achieved in one and the other age group of examinees, we can see that one year after the surgery favorable outcomes of the surgery are more present at the younger age group, from 3 to 6, because improvement of visual acuity of the right and

the left eye and reduction of strabismus angle have been reached as a result of the surgery, exercises against amblyopia and exercises for improvement of binocular vision because at this age the development of binocular vision is still not finished and we can impact on its development, which is not possible at the older age group.

Table 2. Differences in the age group 7-14 years

	The first review	After surgery	One year after surgery	In total	df1	df2	F	p
	$\mu \pm \sigma$	$\mu \pm \sigma$	$\mu \pm \sigma$	$\mu \pm \sigma$				
Visual acuity of the right eye	0,81 \pm 0,20	0,81 \pm 0,20	0,87 \pm 0,19	0,83 \pm 0,20	2	54	0,637	0,533
Visual acuity of the left eye	0,82 \pm 0,24	0,82 \pm 0,24	0,82 \pm 0,23	0,82 \pm 0,23	2	54	0,003	0,997
The angle of strabismus	25,21 \pm 7,44	10,05 \pm 5,91	12,16 \pm 6,09	15,81 \pm 9,31	2	54	30,149	0,000

Discussion

If treatment is combined with binoculars, orthoptic-pleoptic treatment does not reach a desired effect, i.e. removal of deviation and improvement of binocular vision. In this case, one should be subjected to surgery. A huge deviation angle requires a surgical treatment because no other method of treatment can remove it. A surgical treatment has psychological reasons for esthetic appearance and social reasons because it is known that orthoptic-pleoptic treatment is not acceptable to many patients because of its financial expenses. Time of surgery at congenital or infantile esotropia is different at some authors. Some of them speak for early surgeries, up to the first year of life, while the others speak for a surgery between the age of 2 and 3. (Bradamante, 1994). Simonsz (2006) conducted a study to investigate early surgeries of congenital strabismus in relation to late surgeries of congenital strabismus. Optimal age for surgery of congenital esotropia is different at many authors. Those for early surgery believe that further loss of binocular may be prevented by early surgery, while some of them believe that binocular vision can be maintained by early surgery. This study made a comparison between early and late surgeries. Children in early age (6-34 months), 231 children, and those aged 32-60 months, 301 of them, underwent a surgery. All of them were determined a strabismus angle, refraction anomaly, a degree of amblyopia and limited abduction. The children were re-examined at the age of 6, when a degree of binocular vision, strabismus angle and remaining amblyopia were determined. Refraction errors, amblyopia and limited abduction were equal in both groups of examinees, but a strabismus angle was a bit higher at younger examinees. At the age of 6, 13,5% of children who underwent a surgery at early group in respect to 3,9% of children in late group had a stereovision examined by Titmus test. Considering strabismus angle, there was no difference in both groups. When it is about acuity, early group had small, but significant advantage. In both groups there were children who had to be subjected to re-surgery at the age of 6. The authors think that children who underwent a surgery at early age had better acuity and stereovision at the age of 6 in comparison with children who underwent a surgery at later age. The study conducted by Alajbegović-Halimić (2003), in duration of three years, included 246 children from 4 to 6. Its aim was to determine a level of visual activity at children, following results of occlusion therapy of esotropic and anisometric group and analyze factors of effect on reached results. Analyzing factors of influence, they arrived at conclusion that all-day occlusion at esotropic amblyopia represents the best choice of treatment. A gained visus of 0,5 was considered a good result or better on amblyopic eye. Similar research was conducted by Krković and co (2003), whose aim was to establish how big is the influence of surgical correction of strabismus angle at children with esotropia on development of binocular vision, in relation to conservative treatment. The examinees were grouped in two groups, the first one with children treated by a surgery and then by orthoptic-pleoptic treatment, while the other group is composed of children treated by conservative orthoptic method. Each group of children had 50 examinees – thus 100 examinees in total. Establishment of binocular vision was followed in the period of one year. Examinees were from 4 to 8 years old. After a year of treatment, it could be seen that the first group examinees reached far better results than those from the second group. In the first group, 1,8% of examinees

reached simultaneous perception, 72% of them gained fusion along with simultaneous perception, and 20% of examinees reached all three levels, including stereovision. In the second group, 26% of examinees developed simultaneous perception, 28% of them developed fusion along with simultaneous perception, and all three levels were reached by 8% of examinees. It is important to say that 38% of examinees from the second group did not show improvement in treatment and after a year remained without binocular vision. It may be concluded that even at small values of strabismus angle it is recommended to make a surgery and establish orthophoria prior to conservative treatment because in that way qualitative binocular vision can be reached. Similar research was conducted by Dorn and Petrinović-Dorešić (2008), whose aim was to show stereoscopic acuity at strabismus and ametropic amblyopia. The research was conducted on patients aged from 1 to 25, who were divided into two subgroups: the subgroup with strabismus amblyopia (the patients with amblyopia on one eye and mainly with early appearance of strabismus) and a subgroup with refraction amblyopia, caused by missing proper correction of refraction error. Patients with strabismus amblyopia are further divided into two groups: those treated by surgery and those who did not undergo a surgery. The patients examined were those with esotropia, exotropia and microstrabismus. Type and size of strabismus angle (esotropia) and type and size of refraction error had a significant influence of obtained values of stereoscopic acuity showing impairment of stereopsis. Thus, it was noted that the greatest absence of stereovision was present at patients with esotropia, 83% of them who underwent a surgery and 55% of those who did not undergo the surgery. Similar results were reached by Shaouly and co. (1994) whose aim was to examine clinical characteristics and long-term post-surgical results at infantile esotropia. They classified 103 patients (206 eyes) with infantile esotropia and followed them for 8 years after the surgery from what four groups derived. 28 out of 103 patients (27%) has subnormal binocular vision, 24 (23%) had microtropia, 43 (42%) has a small deviation angle and 8 (8%) had a great deviation angle. Acuity of 20/30 or better was maintained at 174 out of 206 eyes. In the group of patients with subnormal binocular vision (28), the eyes kept horizontal position. However, 6 of 30 patients in the group with microtropia and 11 of 43 patients in the group with small deviation angle lost stability of horizontal eye position. They found out that two variables, latent and manifest nystagmus and persistent amblyopia at the time of surgery, had bad influence on post-surgical results. However, at patients with smaller pre-surgical deviation angle and at patients who underwent a surgery prior to the first year of life, it showed that it is possible to reach optimal results (subnormal binocular vision) or reach desired results (microtropia). Thus, the authors recommend a surgery after the treatment of amblyopia and whenever possible during the first year of life. Also, surgical experiences of Čelić and Dorn (2004), which refer to the group of patients operated from strabismus during the period of five years, up to the third year of life, 10,6% of children underwent a surgery. Most children who underwent a surgery were 3-7 years old, i.e. 33,2%, 7-14 years old, i.e. 23,7% and a relatively high number of adult patients, i.e. 28,9%. During this period, a slight increase of a number of surgeries was noted, while the age at the time of surgery was moving towards the younger children. Čelić and Dorn (2004) made some researches which refer to the group of 50 children with infantile esotropia who underwent a surgery at the age 1 to 4. The time of surgery at children aged 1 to 2 was present in 16% cases and if strabismus angle was big. 44% of children underwent a surgery at the age of 3 to 4. At first year of life, no child was subjected to a surgery because parents did not agree on it at such early age. Surgeries were made after the second year of life when it is more possible to make an accurate diagnostics and certain conservative treatment was conducted. Strabismus angle was often big, up to 30°, at 50% of patients. Taking into consideration the results achieved in this research, it can be concluded that favorable conditions for reaching and improvement of function of binocular vision are more present at the age group from 3 to 6. Therefore, it can be said that an operative treatment at appropriate age determines favorable conditions for reaching and strengthening binocular cooperation, i.e. its functional improvement. But, still there needs to be much more work, effort and patience because the treatment does not end there, but lasts for years. The importance of this research is to point to necessity of early detection and prevention of amblyopia and strabismus, which implies the need for early systematic examination of pre-school children and the need for work and impact of a defectologist – typhlogist at health, pre-school and school institutions. It is necessary to work on development of cooperation between pediatrician-child-parent-defectologist-strabologist because prognosis for treatment is good if signs of strabismus and amblyopia are recognized on time and if the treatment is initiated promptly. A thorough organization of work and education in primary and secondary health care at health institutions as well as implementation of projects related to early detection of strabismus and amblyopia are needed, starting from pediatric departments at the Health center, pre-school institutions and institutions of primary and secondary education. Also, the importance of this research reflects also in the fact that application of orthoptic-pleoptic treatment after a surgical treatment of esotropia, with appropriate correction and exercises, provide positive results in improving visual acuity and establishing and improving binocular cooperation.

CONCLUSION

Pursuant to the applied methodology of research, analysis and interpretation of achieved results, we arrived at the following conclusions:

- that there are differences in average values of visual acuity of the right and left eye (visual acuity of the right eye and visual acuity of the left eye) among both age groups of examinees from 3 to 6 and from 7 to 14 in initial examination, immediately after the surgery and one year after the surgery;
- that visual acuity of the left eye (visual acuity of the left eye) at the age group from 3 to 6 has been significantly increased in respect to the first-initial examination, which means that visual acuity of the left eye has been improved, while on the other hand, there has been no great change in visual acuity of the right eye;
- there has been no great change in visual acuity of the left and right eye at the age group from 7 to 14 during the period of one year after the surgery in respect to the first examination;
- that the average value of strabismus angle size (esotropia) at the age group from 3 to 6 at the first-initial examination was higher than the average value of strabismus angle size (esotropia) at the age group from 7 to 14;
- that the average value of strabismus angle size (esotropia) at both age groups in the second and the third period of observation is significantly lower in respect to the first-initial examination, which is the result of a surgical treatment and orthoptic-pleoptic exercises;

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