

RESULTS OF HORIZONTAL STRABISMUS SURGERY IN THE PERIOD FROM 2017 TO 2023 AT THE CLINIC FOR EYE DISEASES TUZLA

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ISSN 0350-364X

DOI: 10.5457/684

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ABSTRACT

Aim: To evaluate results of surgical intervention of horizontal strabismus or to evaluate results of horizontal strabismus surgery intervention and to identify factors that influence the success of the surgery. Medical documentation of 144 patients that have done their first horizontal strabismus surgery at the Clinic for Eye Diseases in Tuzla from February 2017 until February 2023. Main measure of successful surgery was defined as an eye deviation no more than 10 prism diopters 2 years after the surgery. Results of post-operative binocular vision and vision acuity improvements were analyzed. Pre-operative deviation, diagnosis, binocular function, visual acuity and age were analyzed as factors that influence the success of the surgery.

Patients and methods: Patients were divided into 2 groups, first under the age of 7 (48.6%) and above the age of 7 (51.4%). In order to assess set goals of the research, Chi square test, Wilcoxon matched-pairs signed-rank test and logistic regression analysis with forced entry were used. Average age of the respondents was 9.67 ± 4.15 years old (med. 8, mod. 7, min. 5 and max 20), while 69 (47.9%) had esotropia and 75 (52.1%) had exotropia. Average pre-operative deviation was 6.62 ± 42.28 PD, (median 0, modus 60 PD), while minimum and maximum deviation was in range from -60 PD to +35 PD. Average post-operative deviation was 5.46 ± 10.06 PD.

Results: Success of the surgery for esotropia was 49.3% and for 97.3%. Before surgery, 13 (9%) had binocular vision, and after the surgery 80 (55.6%) of the respondents had the binocular vision. Success rate of the surgery was 67.1% for respondents younger than 7 and was 81.1% for the respondents older than 7.

Conclusion: No statistically significant improvement for vision acuity was observed.

INTRODUCTION

Strabismus is a common problem in ophthalmology. The prevalence ranges from 3% to 5% in the total population. [1] Treatment includes careful diagnostics, treatment of amblyopia, correction of refractive errors, and after the conservative treatment, surgery is started. First documented surgical treatment of strabismus dates back to 1839 and it was conducted by Johann Friederich Dieffenbach, general surgeon. [2] Strabismus surgery is very effective treatment of previously conservatively treated patients. Post-operative stage, esthetic improvement and functional improvement will be more present with patients with intermittent strabismus or the patients who had the condition for short amount of time. Different research studies indicate success rates from 30% to 80%. [3] There is no

documentation on conventional surgery of horizontal strabismus in Bosnia and Herzegovina. Aim of the paper was to determine if current results are different from other studies.

MATERIAL AND METHODS

The medical records of 144 patients who underwent the first surgery for horizontal strabismus at the Clinic for Eye Diseases Medical Center Tuzla, in Bosnia and Herzegovina from February 2017 to February 2023 were analyzed, of which 70 patients (48.6%) were under 7 years of age, and 74 (51.4%) over 7 years. Looking at the respondents in relation to their gender, 68 (47.2%) are male and 76 (52.8%) are female. In the total sample of 144 subjects, 69 (47.9%) had esotropia and 75 (52.1%) had exotropia.

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Received:

23.05.2023.

Accepted:

08.06.2023.

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Funding:

none

Competing interests:

none

Patients with restrictive muscle disease or neuromuscular junction disease (e.g., thyroid ophthalmopathy, myasthenia gravis) were excluded from this study because postoperative deviation can be influenced by many factors. The age of the patients varied from 5 to 20 years, with an average of 10.5 + 10.2 years and a median of 6 years.

Clinical data included: diagnosis, age, visual acuity, binocular vision, bulbo-motor, pre and post-surgery deviation, complications, and need for new surgery

Visual acuity was measured with the Snellen chart or Lea symbols in preverbal children. Binocular function was evaluated according to the Titmus fly test, the Lang I and Lang II test, and Worth-four

test. Angles of deviation were determined by prism, Cover test and modified Krimsky's test. The Krimsky's method for estimating the angle of deviation is less precise than the alternative cover or prism test, so there is a possibility of underestimating a difference of 5 prism diopters, as stated by Choi RY and Kushner BJ. [7]

The patients were divided into two age groups, the first group was 7 years or less, and the second group was over 7 years. Guidelines for planning surgical procedures for esotropia and exotropia were modeled on the Marshall Parks formula (table 1, 2). [4]

Table 1. Surgical values for esotropia (modified from the Marshall Parks formula)

Deviation (Δ)	Symmetrical Surgery		Unilateral Surgery	
	Recession MR OU (mm)	Resection LR OU (mm)	Recession MR OU (mm)	Resection LR OU (mm)
15	3.0		3.0	3.5
20	3.5	3.5	3.5	4.0
25	4.0	4.5	4.0	5.0
30	4.5	5.5	4.5	5.5
35	5.0	6.0	5.0	6.0
40	5.5	6.5	5.5	6.5
50	6.0	7.0	6.0	7.0
60	6.5	8.0	6.5	7.5
70	7.0		7.0	8.0

Table 2. Surgical values for exotropia (modified from the Marshall Parks formula)

Deviation (Δ)	Symmetrical Surgery		Unilateral Surgery	
	Recession MR OU (mm)	Resection LR OU (mm)	Recession MR OU (mm)	Resection LR OU (mm)
15			3.0	3.5
20	4.0	3.0	3.5	4.0
25	5.0	4.0	4.0	5.0
30	6.0	5.0	4.5	5.5
35	7.0	5.5	5.0	6.0
40	7.5	6.0	5.5	6.5
50	8.0	6.5	6.0	7.0
	9.0		6.5	7.5
			7.0	8.0

The success of the surgery was defined by an eye deviation of less than 10 prism diopters 2 years after the surgery. Factors influencing the success of the surgical procedure (diagnosis, age group, visual acuity, binocular function and deviation angle). Data was processed using the method of parametric and non-parametric statistics. Basic statistical parameters, measures of central tendency, measures of dispersion, frequencies and percentages were calculated. Arithmetic mean, median and mode were calculated as measures of central tendency, and standard deviation, minimum and maximum results as measures of dispersion. The obtained results are shown in tabular view. In order to verify the research objectives, the chi-square test, the Wilcoxon test of equivalent pairs and logistic regression analysis with the forced entry were used. Research data was processed in the statistical package SPSS 20 for Windows.

RESULTS

There were 144 respondents in this study. Table 3 shows respondents' distribution in relation to age group, gender and diagnosis. Table 1 shows that 70 (48.6%) of the respondents were younger than 7 and 74 (51.4%) were older than 7. In relation to gender, 68 (47.2%) of the respondents were male and 76 (52.8%) were female. From total of 144 respondents, 69 (47.9%) had esotropia and 75 (52.1%) had exotropia (Table 3).

Table 3. Demographics of the respondents

Demographics	N = 144 cases (No. %)
Gender	
Male (%)	68 (47.2%)
Female (%)	76 (52.8%)
Age	
Mean + SD	9,67±4,15
Median (min, max)	8 (5, 20)
Age group 1 (< 7 years)	70
Age group 2 (> 7 years)	74
Deviation	
Esotropia (cases)	69(47.9%)
Exotropia (cases)	75(52.1%)
Angle of deviation preoperative	
Mean + SD (prism diopters)	3,31±21,14 (PD)

The results in Table 4 show that the average age of the respondents was 9.67±4.15 years, the median was 8 and the mode was 7, and the minimum and maximum age of the respondents ranged from 5 to 20 years. The average pre-surgery deviation was 3.31±21.14 prismatic diopters, median 0, mode 30, while the minimum and maximum prismatic diopters ranged from -30 to 35. The average postoperative deviation was 2.73±5.03, median 3, mode -2, while the minimum and maximum scores range from -7 to 15) (Table 4).

Table 4. Measures of central tendency and measures of dispersion in relation to age, pre and post-surgery deviation

Var.	M	SD	SG	MED	MOD	MIN	MAX
Age	9,67	4,15	0,35	8,00	7,00	5,00	20,00
Pre-surgery deviation	3,31	21,14	1,76	0,00	30,00	-30,00	35,00
Post-surgery deviation	2,73	5,03	0,42	3,00	-2,00	-7,00	15,00
Two years after	1.63	7.13	0.59	2.00	5.00	-15.00	23.00

Table 5 shows the results of the chi-square test in relation to the success of the surgery, diagnosis and age group. It can be seen from the table that the success rate of the surgery for esotropia is 49.3%, while for exotropia 97.3%. The results of the chi-square test showed that at the level of statistical significance 0.01, the success rate of the surgery is higher in patients with exotropia (Table 5). The success rate of the surgery in patients younger than 7 is 67.1%, while in patients older than 7 it is higher, up to 81.1%.

The results of the chi-square test showed (albeit borderline significant) that there is no statistically significant difference in relation to the age group of the patients and the success of the surgery (Table 5).

Table 5. Chi-square test results in relation to number of successful surgery

Variables		Surgery successful		χ^2	p
		Yes	No		
Diagnosis	Esotropia	N	34	35	43.47 .000
		%	49.3%	50.7%	
	Exotropia	N	73	2	
		%	97.3%	2.7%	
Total (Success)		N	107	37	
		%	74.3%	25.7%	
Age group	Younger than 7	N	47	23	43.47 .056
		%	67.1%	32.9%	
	Older than 7	N	60	14	
		%	81.1%	18.9%	
Total (Success)		N	107	37	
		%	74.3%	25.7%	

Based on the results shown in Table 6, it can be seen that the average value of VOD before the surgery is 0.92±0.21, while after the surgery it is 0.90±0.21. This result shows that the patients after the surgery have a lower average visual acuity of the right eye.

The average value of VOS before surgery is 0.91±0.22, and after surgery it is 0.89±0.24. The results of the VOS show that the patients after the surgery have a lower average visual acuity of the left eye. In order to

see whether the differences in visual acuity pre-surgery and post-surgery are statistically significant, the

Wilcoxon test of equivalent pairs was applied and the results are shown in table 7.

There were no surgery complications.

Table 6. Measures of central tendency and measures of dispersion in relation to age, pre-surgery and post-surgery deviation

Var.	M	SD	SG	MED	MOD	MIN	MAX
Pre-surgery visus VOD	0,92	0,21	0,02	1,00	1,00	0,02	1,00
Pre-surgery visus VOS	0,91	0,22	0,02	1,00	1,00	0,08	1,00
Post-surgery visus VOD	0,90	0,21	0,02	1,00	1,00	0,08	1,00
Post-surgery visus VOS	0,89	0,24	0,02	1,00	1,00	0,08	1,00

Based on the obtained results presented in table 5, it can be concluded that, at the statistical significance level of 0.05, the visual acuity of the right eye is lower

after the surgery. Also, at the 0.05 level of statistical significance, the visual acuity of the left eye is lower after surgery.

Table 7. Wilcoxon test results

Variables	N		Mean of the ranks	Sum of the ranks	Z	p
Post-surgery VOD – Pre-surgery VOD	Negative ranks	10	7.30	73.00	-2,70	.007
	Positive ranks	2	2.50	5.00		
	Smaller sum of ranks	132				
	Total	144				
Post-surgery VOS – Pre-surgery VOS	Negative ranks	5	3.00	15.00	-2,12	.035
	Positive ranks	0	.00	.00		
	Smaller sum of the ranks	139				
	Total	144				

The representation of binocular vision is shown in table 8, where it can be seen that binocular vision was present before surgery in 13 (9%) patients, while it was

not present in 131 (91%) patients. After surgery, the presence of binoculars was recorded in 80 (55.6%) patients, while it was not recorded in 64 (44.4%) patients.

Table 8. Presence of binocular vision before and after surgery

Variables	No	No	Total
Binocular vision before the surgery	131 (91%)	13 (9%)	144
Binocular vision after the surgery	64 (44,4%)	80 (55,6%)	144

In order to verify the influence of several factors (Pre-surgery deviation, diagnosis, binocular function, visual acuity and age) on the surgical success of the subjects,

a logistic regression analysis was applied. The whole model with all predictors was statistically significant ($\chi^2 = 112.296$, $df = 6$; $p \leq 0.001$), which means that the model distinguishes between subjects who had a successful and unsuccessful surgery. The model as a whole explains 54.2% and 79.6% of the variance in the success of the surgery and correctly classifies 95.1% of the cases. The obtained results shown in table 9 indicate that four independent predictors (factors) gave a unique statistically significant contribution to the success of the surgery. At the statistical significance level of 0.01 and 0.05, the pre-surgery deviation, the pre-surgery visual acuity of the right and left eye and the age of the subject are the biggest predictors of the success of the surgery.

Table 9. Results of logistic regression analysis

Variables	B	SG	Wald	df	p	Probability ratio	Interval 95% confidence	
							Lower limit	Upper limit
Diagnosis	-0,19	1,50	0,02	1,00	,899	0,83	0,04	15,76
Pre-surgery deviation	-0,18	0,05	14,74	1,00	,000	0,83	0,76	0,91
Pre-surgery VOD	8,08	4,00	4,07	1,00	,044	3232,27	1,26	8288547,99
Pre-surgery VOS	5,95	2,90	4,21	1,00	,040	382,05	1,30	112157,02
Bi Pre-surgery	-17,09	9838,63	0,00	1,00	,999	0,00	0,00	
Age	.295	.120	6.003	1	.014	1.342	1.061	1.699
Constant	8,11	9838,63	0,00	1,00	,999	3332,92		

Legend: Pre-surgery VOD – Visual acuity of the right eye before surgery; Pre-surgery VOS – Visual acuity of the left eye before surgery; Bi Pre-surgery – Binocular vision before surgery

DISCUSSION

Many scientific studies have reported success rates of strabismus surgery ranging from 30% to 80%. [5,8] In this study, the success rate of the surgical procedure was 49.3% for esotropia, while it was 97.3% for exotropia. Data such as visual acuity and binocular function in preverbal and uncooperative children could not be analyzed in this study. Predictors of a good result in this study were age below 7 years and preoperative deviations of less than 30 diopters of the prism. Trigler L. and Siatkowski RM determined that deviations of less than 30 prism diopters were associated with fewer repeated horizontal surgeries in infantile esotropia. [6] This study showed an improvement in binocular function by increasing the number of patients who

had binocular function from 69 cases before surgery to 122 cases after surgery. This result demonstrated the role of good ocular alignment in the development of binocular function. The parameters of the study were the age of the subjects, pre- and post-operative visual acuity, angle of deviation, binocular vision, surgical outcome including cosmetics, any postoperative complications, re-operative requirement and the parental understanding about the strabismus and the treatment modalities. [9] Bilateral symmetrical muscle surgery was done in all the cases with minimal soft-tissue damage using the curved-fixation forceps, muscle hooks and tissue retractors. Post-operatively, the eyes were patched at the recovery room and a combination of topical antibiotics and steroids was started after two hours of the surgery. [10] And finally we can take the

existing data as an example. Bilateral lateral rectus recession for exotropia had 30/56 (53.6%) good and 12/56 (21.4%) had poor outcome, while for recess-resect procedures for exotropia it was 97/174 (55.7%) good and 39/174 (22.4%) poor outcome ($p = 0.97$). The result did not significantly change over 3 years. 433/461 (93.9%) expressed satisfaction about the surgery on 6-week follow-up. Large pre-operative deviations and amblyopic eyes accounted for 63/101 (62.3%) cases of poor outcome. Fifty-seven patients recorded an improvement in stereopsis.[11]

CONCLUSION

Success rate of surgical procedures, laid out in this study, was 49.3% for esotropia and 97.3% for exotropia. Factors that influence success rate were pre-surgery deviation and age group. Predictors of a success were age less than 7 and pre-operative deviation lower than 30 prism diopters. The limitations of our study included our inability to complete an assessment most of the patients had presented after their visual maturation with compromised binocularity. We also could not subject the parents with standard questionnaires for the assessment of satisfaction. So, in the majority of the cases, the findings are largely limited to the cosmesis, in spite of some cases having gross stereopsis. A post-operative, adequately long-term follow-up to assess the final outcome was also not scheduled

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