e-ISSN 2795-3248
p-ISSN 2795-3222

10.5281/zenodo.11099188 Vol. 07 Issue 04 April - 2024 Manuscript ID: #1336

Relationship and Impact Of Strabismus On Head And Eye Movement

[1*]Ohwin Peggy Ejiro, [1]Ofulue Ofioritse Ogheneyoma, [1]Ovili-Odili Zeinab Blessing, [1]Cooke Esther Eguono,, [2]Gbaranor Kekii Barinua, [1]Eyeregba Oghenetega Elizabeth & [1]EPIDEI Elizabeth Ebimobo-ere

[1]Department of Physiology, Faculty of Basic Medical Sciences, Delta State University Abraka, Delta State, Nigeria.

[2]Department of Human Physiology, College of Medical Sciences, Rivers State University, Rivers State, South-South, Nigeria

Corresponding author: peohwin@gmail.com

ABSTRACT

Strabismus also known as misaligned eyes is disorder associated with sense of sight that can affect physiological and psycho-social activity of humans and in this study, its effect on eye movement with slight or no head movement of subjects. This study aimed at evaluating the impact of strabismus on head and eye movement. Subjects recruited were strabismic, myopic and relative emmetropes. Effect of strabismus on visual acuity was attained using Snellens' distance and near chart but result showed no relationship when compared with emmetrope's acuity. Near point of accommodation using meter rule was also carried out showing accommodation break-up, recovery and amplitude of accommodation; giving the result that strabismus does not have any effect on accommodation. Hirschberg or broad H test was used in this study to show the effect of strabismus on eye movement and head movement, and it showed that for eye movement some muscles are suppressed or defective, with the lateral deviation type of strabismus- esotropia and exotropia recruited for this study, showing that media and lateral rectus can be affected and that there is no relative impact on head movement. This study has shown that although strabismus is an eye defect it does not have any effect or impact on visual acuity, accommodation, or on head movement, it only has impact on eye movement with by suppressing eye muscles.

KEYWORDS:

Eye Movement, Snellen's chart, Visual acuity, Medial rectus, Lateral rectus, Head Movement

Introduction

Strabismus is known as the abnormal alignment of the eyes, and results in several unfavorable functional and psycho-social repercussions, which can be obviated by surgery(1). Even so, adults with strabismus frequently put off getting therapy. According to Coats *et al*., (2005), subjects who acquire strabismus before the age of nine on average wait 29 years before seeking therapy. The typical delay for subjects with later-onset strabismus is ten years. Surgery not being given by eye care professionals was a major factor in subjects delaying treatment(2).

The most frequent cause of visual impairment in older children with CS (crouzon syndrome) is strabismus (3). Exotropia with a V-pattern and "overelevation in adduction" are two common characteristics of strabismus. Tan *et al.*, (2005) demonstrated that the extortion of the rectus muscle pulleys can explain both the pattern strabismus and the dissociated vertical strabismus associated with CS (4). According to Weiss *et al.*, (2014), he stated that the ensuing extortion of the globe causes the retinal picture and the target's spatial location to be angularly misaligned. subjects with strabismus may experience diplopia, impaired depth perception, asthenopia, and difficulty driving (5). subjects with esotropia may suffer from a reduced binocular field of view, while those with exotropia may experience a panoramic field of view (6). Strabismus commonly results in amblyopia, which itself presents a range of deficits in spatial vision and impairments in motor control that can limit performance on real-world visuomotor tasks (7-9). Reduced binocularity due to strabismus can lead to greater risks of falls and injuries in the elderly (10). Diplopia is a particularly problematic issue that interferes with everyday tasks and can prevent subjects from driving (11). Strabismus that occurs early in life may give rise to amblyopia but is less likely to result in diplopia due to mechanisms of interocular suppression. This, however, does not mean that subjects with early-onset strabismus will not develop diplopia. In a multicenter retrospective study involving 299 subjects who underwent strabismus surgery, nearly a third of subjects with strabismus that developed before 9 years of age complained of diplopia (12, 13). The most common reason for diplopia developing in subjects with childhood-onset strabismus is a change in the angle of deviation (14). subjects with strabismus may therefore suffer from a range of visual problems and the specific symptoms experienced by individuals will depend on patient-specific factors such as the age of onset of strabismus, the type of deviation, and its magnitude. Over the years research has shown that there is a relationship between eye and head movement, without much research work done to know if an eye defect (Strabismus) can have an impact on eye and head movement since there is a relationship. This research is to ascertain the impact and relationship of strabismus on eye and head movement.

Materials and Methods

A total of 30 students, both male and female subjects from the Faculty of Basic medical science, Delta state University, Abraka, Delta state, Nigeria were recruited. A systematic sampling technique was employed in this study. The students between ages 16-25 years sampled after education and seeking of their consent. The parameters considered by this research include age, visual acuity, near point of accommodation, the amplitude of accommodation as well as eye and head movement using the appropriate methods and instruments. The materials used were the Snellen’s chart for visual acuity, Meter rulefor near point of accommodation, Light pen for Hirschberg or broad H test to check eye and head movement and notebook for documenting results. The age of participants was recorded and the type of Strabismus was determined according to Helveston (2010)(15). Visual acuity was determined using a Snellen chart at 6 meters distance. Near point of accommodation (NPC) was done using a meter rule and a pen while Amplitude of accommodation (AA) was determined by dividing one (1) by the averse of break, in the near point of accommodation.

Eye movement and Head movement were determined using the Hirschberg test (Eric 2016). Using the H motility pattern. annotations indicating the muscle(s) being utilized to achieve each position was observed for each of the nine postures. The subject's eye was checked to ensure the eye alignment during primary gaze was noted before having them move their eyes in a "H" pattern and any minor and major movement of the head during this test was recorded. Subjects were recruited base of the College of basic medical science with and without strabismus and those with myopia.

Data obtained were subjected to Statistical Package for Social Sciences (SPSS version 22.0). The descriptive (mean and standard error of the mean) was calculated. The chi-square test at the 95% confidence interval was used for this study and a p-value lesser than 0.05 was considered statistically significant. The duration of this study was for three (3) months, starting in June 2022 and ending in the month of September 2022.

RESULTS

Table 1 shows the age distribution of the respondents. From the result, the majority of the subjects were within the age of 19 (n=8, 26.7%).

Table 2 shows the distribution of eye disorders among the studied participants. From the result, all subjects recorded equal numbers of disorders.

The table 3 above shows the distribution of respondents' right eye and visual acuity. From the result, it showed that the majority of the respondents had visual acuity 6/5 (26.7%) while 6/34, (3.3%) and 6/60, (3.3) were the least occurred in the studied population.

Table 4 shows the distribution of respondents' left eye and visual acuity. From the result, it showed that the majority of the respondents had visual acuity 6/5 (26.7%) while 6/12, (3.3%), 6/15, (3.3%), 6/24, (3.3%) and 6/36, (3.3) were the least occurred in the studied population.

Table 5 shows the distribution of respondents' both eyes and visual acuity. From the result, it showed that the majority of the respondents had visual acuity 6/4 (30.0%) on both eyes while 6/12, (3.3%), 6/18, (3.3%), 6/34, (3.3%) and 6/36, (3.3) were the least occurred in the studied population.

Table 6 shows the distribution of respondents based on accommodation break. From the result, it showed that the majority of the respondents experienced accommodation break at 5cm, (16.7%) in the studied population.

Table 7 shows the distribution of respondents based on accommodation recovery. From the result, it showed that the majority of the respondents experienced accommodation recovery at 12cm, (16.7%) in the studied population.

Table 8 shows the distribution of respondents based on head movement. From the result, it showed that the majority of the respondents did not show any head movement (n=16, 53.3%), although 13(3.3%) showed slight head movement but 1(3.3%) showed a complete head movement.

There is significant relationship between eye movement of the right eyes and head movement at $P<0.05$ ($P=0.025$).

Table 1: Age Distribution of Respondents

Age (years)	Frequency	Percentage (%)
16	2	6.7
17	7	23.3
18	7	23.3
19	8	26.7
20	4	13.3
21	1	3.3
22	1	3.3

Table 2: Distribution of Eye Disorder among the studied Participants

Disorders	Frequency	Percentage (%)
Stabismus	10	33.3
Control	10	33.3
Myopia	10	33.3

Table 3: Distribution of Respondents Right Eye and Visual Acuity

Visual Acuity	Frequency	Percentage (%)
6/12	4	13.3
6/24	3	10.0
6/34	1	3.3
6/4	2	6.7
6/5	8	26.7
6/6	5	16.7
6/60	1	3.3
6/9	5	16.7

Table 4: Distribution of Respondents Left Eye and Visual Acuity

6/9	**7**	**23.3**

Table 5: Distribution of Respondents Both Eyes and Visual Acuity

Visual Acuity	Frequency	Percentage (%)
6/12	1	3.3
6/18	1	3.3
6/34	1	3.3
6/36	1	3.3
6/4	9	30.0
6/5	7	23.3
6/6	6	20.0

6/9	4	13.3

Table 6: Distribution of Respondents Based on Accommodation Break

Accommodation Break (cm)	Frequency	Percentage%
1	1	3.3
10	1	3.3
10.5	1	3.3
10	2	6.7
11	1	3.3
12	1	3.3
3	1	3.3
5	5	16.7
6	1	3.3
6	2	6.7
7	4	13.3
7	1	3.3
8	2	6.7
8.5	1	3.3
8	3	10.0
9	1	3.3
9	2	6.7

Table 7: Distribution of Respondents Based on Accommodation Recovery

Accommodation Recovery (cm)	Frequency	Percentage
10	3	10.0
10	3	10.0
11	1	3.3
11	4	13.3
12	3	10.0
12	5	16.7
13	2	6.7
14	1	3.3
15	1	3.3
16	1	3.3
20	1	3.3
10	1	3.3
7	1	3.3
8	1	3.3
9	2	6.7

Table 8: Distribution of Respondents Based on Head Movement

Head Movement	Frequency	Percentage (%)
Head movement	1	3.3
No Movement	16	53.3
Slight Movement	13	43.3

Table 9: Relationship Between Left Eye Visual Acuity and Eyes Disorders

Visual Acuity	Control Frequency (%)	Strabismus Frequency (%)	Myopia Frequency (%)
6/12	0 (0)	0 (0)	1 (100.0)
6/15	0 (0)	0 (0)	1 (100.0)
6/24	0 (0)	0 (0)	1 (100.0)
6/36	0 (0)	0 (0)	1 (100.0)
6/60	0 (0)	0 (0)	1 (100.0)
6/4	4 (66.7)	2 (33.3)	0 (0.0)
6/5	2 (25.0)	4 (50.0)	2 (25.0)
6/6	2 (50.0)	0 (0.0)	2 (50.0)
6/9	2 (28.6)	4 (57.1)	1 (14.3)

Table 10: Relationship Between Both Eyes Visual Acuity and Eyes Disorders

Visual Acuity	Control Frequency (%)	Strabismus Frequency (%)	Myopia Frequency (%)
6/12	0 (0.0)	0 (0.0)	1 (100.0)
6/18	0 (0.0)	0 (0.0)	1 (100.0)
6/34	0 (0.0)	0 (0.0)	1 (100.0)
6/36	0 (0.0)	0 (0.0)	1 (100.0)
6/4	4 (44.4)	5 (55.6)	0 (0.0)
6/5	4 (57.1)	0 (0.0)	3 (42.9)
6/6	1 (16.7)	4 (66.7)	1 (16.7)
6/9	1 (25.0)	1 (25.0)	2 (50.0)

Table 11: Relationship Between Head Movement and Eyes Disorders

Head Movement	Control Frequency (%)	Strabismus Frequency (%)	Myopia Frequency (%)
Head Movement	1 (0.0)	0 (0.0)	0 (0.0)
No Movement	6 (37.5)	4 (25.0)	6 (37.5)
Slight Movement	3 (23.1)	6 (46.2)	4 (30.8)

Table 12: Effect of Eye Disorders on Visual Acuity

Visual Acuity	Control	Strabismus	Myopia
	Mean±SEM		
Age	18.40±0.40	18.60±0.62	18.20±0.33
Accommodation Break	7.60±0.85	6.10±0.78	8.40±0.52
Accommodation Recovery	12.20±1.01	10.20±0.51	11.60±0.91

Table 13: Relationship between Eye Movement and Eye Disorder of the left eye

Eye Movement	Control Frequency (%)	Strabismus Frequency (%)	Myopia Frequency (%)
None	10 (100.0)	8 (80.0)	10 (100.0)
MR	0 (0.0)	2 (20.0)	0 (0.0)
LE	0 (0.0)	0 (0.0)	0 (0.0)

Table 14: Relationship between Eye Movement and Eye Disorder of the right eye

Eye Movement	Control Frequency (%)	Strabismus Frequency (%)	Myopia Frequency (%)
None	10 (100.0)	7 (70.0)	10 (100.0)
MR	0 (0.0)	3 (30.0)	0 (0.0)
LE	0 (0.0)	0 (0.0)	0 (0.0)

Table 15: Relationship between Eye Movement and Eye Disorder of the both eyes

Eye Movement	Control Frequency (%)	Strabismus Frequency (%)	Myopia Frequency (%)
None	10 (100.0)	3(30.0)	10 (100.0)
MR	0 (0.0)	1 (10.0)	0 (0.0)
LE	0 (0.0)	6 (60.0)	0 (0.0)

Table 16: Relationship between left eye movement and head movement

Eye Movement	None Frequency (%)	MR Frequency (%)	LE Frequency (%)
No Movement	16 (57.1)	2 (100.0)	0 (0.0)
Slight Movement	12 (42.9)	0 (0.0)	0 (0.0)

Table 17: Relationship between right eye movement and head movement

Eye Movement	None Frequency (%)	MR Frequency (%)	LE Frequency (%)
No Movement	18 (66.7)	0 (0.0)	0 (0.0)
Slight Movement	9 (33.3)	3 (100.0)	0 (0.0)

Table 18: Relationship between eye movement of both eyes and head movement

Eye Movement	None Frequency (%)	MR Frequency (%)	LE Frequency (%)
No Movement	15 (65.2)	0 (0.0)	3 (50.0)
Slight Movement	8 (34.8)	1 (100.0)	3 (50.0)

Discussion

Numerous visual diseases are addressed because they have an impact on the quality of life, including strabismus. Adults with strabismus have also been reported to have low self-esteem, issues with interpersonal relationships, and social anxiety(16). Apart from the psycho-social effect of strabismus, it also affects the movement of the eye and visual acuity but has less or no effect on head movement.

Table 2 shows the even distribution of participants in this research, 10 each for strabismus, myopia, and control (those without any eye defect). Myopia, an eye defect was chosen for this research to show if there is any relationship between eye defects and eye movements apart from strabismus and the control was to get normal eye movements, when there are no eye defects. Table 9, showing the relationship of eye disorders with the VA of the left eye, shows that 66.7% of control, 33% of strabismic subjects, and 0% of myopic subjects had a result of 6/4, 25% of control, 50% of strabismic subjects and 25% myopic subjects had a VA of 6/5, 50% of control, 0% of strabismic subjects and 50% of myopic subjects had a VA result of 6/6, 28% of control, 57% of strabismic patients and 14.3% had a VA result of 6/9. For the right eye, 50% of strabismic subjects, 0% of control, and 50% of myopic subjects had a VA of 6/12%. These results showed that strabismus has an impact on visual acuity and according to Freeman *et al*., 1996, Stating that 'The affected eye's visual acuity is decreased by strabismus, which is a misalignment of one eye's visual axis about the other eye'(17).

Accommodation break showed that the majority of the respondents experienced accommodation break at 5cm, (16.7%) in the studied population in Table 6, showing that strabismus does not have a relative impact on accommodation break in this result and Table 7 shows the distribution of respondents based on accommodation recovery, it showed that the majority of the respondents experienced accommodation recovery at 12cm, (16.7%) in the studied population, also representing that strabismus does not have a relative impact on amplitude of accommodation.Wajuihian also reported to be between 5–10 cm and recovery, 6–13 cm (18).

Based on head movement, the result showed that the majority of the respondents did not show any head movement (n=16, 53.3%), although 13(3.3%) showed slight head movement 1(3.3%) showed a complete head movement representing that strabismus does not have any effect on head movement. Current study confirms that media and lateral muscles defects may not result in obvious abnormal head movement or tilt. (19)

In the relationship of eye movement and strabismus, the two types of strabismus used in this study (esotropia and exotropia) showed that there was a lateral deviation, showing that two muscles are defective during eye movement, the two muscles are MR (medial rectus) and LR (lateral rectus). From the study, it showed that for the left eye, there was 80% with no muscle defect, and 20% with MR defect, for the right eye, 70% did not show any defective or weak muscle and 30% showed that MR is defective or weak. For both eyes, 10% showed that MR was suppressed and 60% showed that LR was suppressed. The relationship of head and eye movement in this study, showed that there is a significant relationship between eye movement of the right eyes and head movement at $P<0.05$ ($P=0.025$). However, the assessment of percentage of defects, suppression was the reason for subject's single vision perception thereby preventing head movement (20)**.**

Conclusion

The research has made a substantial contribution to our understanding of strabismus and its various varieties by demonstrating that esotropia and exotropia are the most prevalent forms of strabismus. It also raised awareness that strabismus affects eye movement, demonstrating that particular eye muscles may be weak or suppressed, that strabismus also has an impact on visual acuity, showing differences between a strabismus sufferer and a strabismus-free individual and there is no relative difference between strabismic subjects and non-strabismic about head movement.

Recommendation

In line with this study, it is recommended that further study should be done on subjects that have hypertropia and hypotropia to confirm the hypothesis that strabismus does not have an effect with head movement.

References

Beauchamp GR, Black BC, Coats DK, Enzenauer RW, Hutchinson AK, Saunders RA, et al. The management of strabismus in adults—I. Clinical characteristics and treatment. Journal of American Association for Pediatric Ophthalmology and Strabismus. 2003;7(4):233-40

Coats DK, Stager DR, Beauchamp GR, Mazow ML, Paysse EA, Felius J. Reasons for delay of surgical intervention in adult strabismus. Archives of Ophthalmology. 2005;123(4):497-9.

Durnian JM, Noonan CP, Marsh IB. The psychosocial effects of adult strabismus: a review. British journal of ophthalmology. 2011;95(4):450-3.

Felius J, Beauchamp GR, Stager Sr DR, Van De Graaf ES, Simonsz HJ. The amblyopia and strabismus questionnaire: English translation, validation, and subscales. American journal of ophthalmology. 2007;143(2):305-10. e1.

Freeman AW, Nguyen VA, Jolly N. Components of visual acuity loss in strabismus. Vision research. 1996;36(5):765-74.

Grant S, Moseley MJ. Amblyopia and real-world visuomotor tasks. Strabismus. 2011;19(3):119-28.

Hatt SR, Leske DA, Kirgis PA, Bradley EA, Holmes JM. The effects of strabismus on quality of life in adults. American journal of ophthalmology. 2007;144(5):643-7.

Helveston EM. Understanding, detecting, and managing strabismus. Community eye health. 2010;23(72):12.

Kreiborg S, Cohen Jr MM. Ocular manifestations of Apert and Crouzon syndromes: qualitative and quantitative findings. Journal of Craniofacial Surgery. 2010;21(5):1354-7.

Kushner BJ. Recently acquired diplopia in adults with long-standing strabismus. Archives of Ophthalmology. 2001;119(12):1795-801.

Movshon J, McKee S, Levi D. The pattern of visual deficits in amblyopia. Investigative ophthalmology & visual science. 2003;44(13):3182.

Pineles SL, Demer JL, Isenberg SJ, Birch EE, Velez FG. Improvement in binocular summation after strabismus surgery. JAMA ophthalmology. 2015;133(3):326-32.

Righi S, Boffano P, Guglielmi V, Rossi P, Martorina M. Diplopia and driving: a problematic issue. Journal of Cranio-Maxillofacial Surgery. 2014;42(7):1329-33.

Stephen P Kraft, Chapter 81 - Abnormal head postures: causes and management, Editor(s): Creig S Hoyt, David Taylor, Pediatric Ophthalmology and Strabismus (Fourth Edition), W.B. Saunders, 2013, Pages 822-835.e1, ISBN 9780702046919, https://doi.org/10.1016/B978-0-7020-4691-9.00081-9

Steven E. Rubin, Rudolph S. Wagner (1986). Ocular torticollis, *Survey of Ophthalmology*; 30 (6): 366-376, ISSN 0039-6257, https://doi.org/10.1016/0039-6257(86)90090-1.

Tan KP, Sargent MA, Poskitt KJ, Lyons CJ. Ocular overelevation in adduction in craniosynostosis: is it the result of excyclorotation of the extraocular muscles? Journal of American Association for Pediatric Ophthalmology and Strabismus. 2005;9(6):550-7.

Wajuihian SO. Normative values for clinical measures used to classify accommodative and vergence anomalies in a sample of high school children in South Africa. J Optom. 2019 Jul-Sep;12(3):143-160. doi: 10.1016/j.optom.2018.03.005. Epub 2018 Jun 19. PMID: 29887298; PMCID: PMC6612036.

Webber AL. The functional impact of amblyopia. Clinical and Experimental Optometry. 2018;101(4):443-50.

Weiss AH, Phillips J, Kelly JP. Crouzon syndrome: relationship of rectus muscle pulley location to pattern strabismus. Investigative ophthalmology & visual science. 2014;55(1):310-7.

Wortham EV, Greenwald MJ. Expanded binocular peripheral visual fields following surgery for esotropia. SLACK Incorporated Thorofare, NJ; 1989. p. 109-12.