

Clinical Characteristics of Horizontal Strabismus in Sudanese Patients

Saif Hassan Al-Rasheed

Department of Binocular Vision, Faculty of Optometry and Visual Sciences, Al-Neelain University, Khartoum, Sudan

ABSTRACT

Purpose: To describe clinical characteristics of horizontal strabismus in Sudanese patients.

Study Design: A retrospective chart review (RCR), a hospital-based study.

Place and Duration of Study: Al-Neelain Eye Hospital, Khartoum, Sudan, from January 2017 to May 2021.

Methods: There were 773 patients, who presented with horizontal strabismus. Data regarding demographics and eye examination including visual acuity, refractive error, and angle of deviation, type of strabismus (intermittent, constant, or alternating) were collected. Data analysis was done by SPSS 23 and statistical significance was set at $P < 0.05$.

Results: The commonest strabismus was esotropia 522 (71.5%). There were 415 (56.8%) females. Most patients had alternating strabismus 436 (59.7%), followed by constant strabismus 206 (28.2%). Vision differed by types of strabismus ($P = 0.032$) with worse vision found in esotropia (mean, 0.69 ± 0.34) compared to exotropia (mean, 0.78 ± 0.33). Refractive error varied by types of strabismus. Hyperopia was common with esotropia (mean, $+3.9 \pm 3.8$ D) and myopia was associated with exotropia (-3.4 ± 2.8 D). The main cause of horizontal strabismus was congenital and presence of refractive error. Hyperopia was a major cause of esotropia for children aged 6 – 10 years which was highly significant ($P < 0.003$) and myopia was the primary reason for exotropia at > 15 years ($P = 0.485$).

Conclusion: The most common type of strabismus among Sudanese was esotropia. Causes of strabismus differed by age group with refractive error and congenital disorders accounting for most of the children aged less than six years and myopia for the majority of exotropia aged more than 15 years.

Key Words: Strabismus, Esotropia, Exotropia, Hypermetropia, Myopia.

How to Cite this Article: Al-Rasheed SH. Clinical Characteristics of Horizontal Strabismus in Sudanese Patients. Pak J Ophthalmol. 2023;**39(3)**:202-207.

Doi: 10.36351/pjo.v39i3.1610

Correspondence: Saif Hassan Al-Rasheed
Al-Neelain University, Khartoum, Sudan
Email: s.rasheed@qu.edu.sa

Received: March 5, 2023

Accepted: June 13, 2023

INTRODUCTION

Strabismus is a public health problem worldwide, particularly among children. The disorder can be horizontal, vertical, or cyclodeviation.¹ It can be manifest or latent misalignment of the visual axes resulting from the deviation of eyes. Strabismus can be congenital or acquired. Literature shows that

strabismus is a common childhood ocular disorder with an estimated worldwide prevalence of 2.3% to 6.0%.^{2,3} The prevalence of strabismus in Western Europe is reported to be between 2% and 5% and the most common type is esotropia.⁴ The predominant type of squint among Asian population is exotropia.^{4,5} The reports from African studies revealed that the prevalence of strabismus is low among children: 0.44% in Nigeria and from 0.3%⁶ to 2.8%⁷ in Sudan with a predominance of esodeviation.^{6,7}

Strabismus is a common anomaly among teenagers, which can be horizontal, vertical, or cyclodeviation due to uncorrected Refractive Error (RE) or neurological disorders.⁸ The condition has a

dangerous consequence on visual development if untreated. It can lead to amblyopia resulting in visual impairment.⁸

Adult onset strabismus commonly paralytic can be due to third, fourth, or sixth nerve palsy or restrictive disorder usually from thyroid dysfunctions.⁹ However, the majority of childhood strabismus is esotropia due to excessive accommodative convergence or intermittent distance exotropia. Esotropia is usually identified earlier and may have a positive relative history of strabismus or uncorrected hypermetropia.⁹

Although the occurrence of strabismus in children is more common than in adults, its management is easier when detected early, while the development of the visual system is yet evolving.¹⁰

Strabismus has presented as a risk factor for abnormal development of the visual system, because it can lead to serious problems occasioned by the sensory adaptation of strabismus, such as abnormal retinal correspondence, amblyopia, and suppression.^{11,12}

Previous studies on strabismus among Sudanese have focused on its prevalence and the distribution of its major types.^{7,8} Only one study has reported details on the clinical features of vertical strabismus.¹³ There are no available data on the clinical features of horizontal strabismus among the Sudanese population. The current study was conducted to present the demographic and clinical data of horizontal strabismus among the Sudanese population.

METHODS

This study was a retrospective a hospital-based chart review, which included 773 patients diagnosed with horizontal strabismus at AL-Neelain Eye Hospital, Khartoum, Sudan. The study reviewed records from June 2017 to June 2021. Records with missing essential information were excluded from the study. Ethical permission was taken from Al-Neelain University, Sudan Ref (21-07-10).

This study used a non-probability sampling technique. 773 patients' records were selected from the Al-Neelain University, Sudan, whose age ranged from 2 to 17 years. There were 337 males and 436 females.

The demographic data included history, age of onset, age at diagnosis, whether the strabismus was intermittent, constant, alternating or fixed and family history of strabismus. The magnitude of deviation was

categorized as follows; slight 10 – 15Δ, moderate 20 – 35Δ, and marked 40 – 90Δ. Distance Visual acuity was assessed by using Snellen tumbling E-chart and refractive errors were determined by using the Retinoscope (Neitz RX, Japan). Direction and amount of deviation was assessed by cover test at 33 cm and 6m for near and distance fixation, respectively. Measurement of the angle of deviation was performed by prism bar and cover test. Evaluation of eye movement and muscle action was performed by ocular motility test using fixation target at near and moving it at nine positions of gaze.

Data analysis was performed by using Statistical Package for the Social Sciences (SPSS) software (Version 25.0. Armonk, NY: IBM Corp., USA). The information was analysed descriptively for categorical variables. *T*-test was used for continuous variables and ANOVA was used for multivariate comparison and statistical significance or *p*-value was set at < 0.05.

RESULTS

A total of 773 patients' records were retrieved. Incomplete records (43in number) were excluded. Therefore, the study included 730 strabismic patients; mean and SD of age at diagnosis was 6.46 ± 5.84 years. Age ranged from less than one year to 40 years. The strabismus was more common among females ($n = 415, 56.8\%$), particularly esotropia representing 302 (41.4%), but this was not statistically significant ($p = 0.216$). More than half of strabismic patients had their age less than six years accounting for 408 (55.9%) and the commonest type of strabismus in this age group was esotropia 298 (40.8%). Details of demographic profile, stratification with respect to age and age of diagnosis and stratification with respect to refractive error and visual acuity is described in Tables 1, 2, 3, 4 and 5.

DISCUSSION

Strabismus is a public health problem and has been studied in various populations in different environments. It is a relatively common ocular disorder among Caucasian children and low prevalence among African inhabitants.¹⁴ This study revealed that esotropia was the most common horizontal strabismus among Sudanese people. This result is comparable to the finding by Olusanya among Nigerians and other studies, which reported that

Table 1: Demographic profile of the patients with Strabismus.

Characteristics	Type of Strabismus		Total N (%)	P-value
	Esotropia N (%)	Exotropia N (%)		
Male	220 (30.1)	95 (13.0)	315 (43.2)	0.216
Female	302 (41.4)	113 (15.5)	415 (56.8)	
Age	(In years-mean (SD) 6.46(5.837))			0.448
Less than 6 years	298 (40.8)	110 (15.1)	408 (55.9)	
6 -10 years	127 (17.4)	50 (6.8)	177 (24.2)	
11 -15 years	65 (8.9)	29 (4.0)	94 (12.9)	
More than 15 years	32 (4.4)	19 (2.6)	51 (7.0)	
Total	522 (71.5)	208 (18.5)	730 (100)	

Table 2: Type, constancy, magnitude and ocular motility among patients with stratified by the age of onset.

Characteristics		Age of Onset n (%)				Total N (%)	P-value
		Since Birth	Less Than a Year	1 – 2Years	3 – 6 Years		
Type	Esotropia	247 (71.2)	158 (69.3)	93 (73.2)	24 (85.7)	522 (71.5)	0.318
	Exotropia	100 (28.8)	70 (30.7)	34 (26.8)	4 (14.3)	208 (28.5)	
Constancy	Alternate	184 (53.0)	155 (68.1)	81 (63.8)	16 (57.2)	436 (59.7)	0.000
	Intermittent	36 (10.4)	29 (12.7)	16 (12.6)	7 (25.0)	88 (12.1)	
	Constant	127 (36.6)	44 (19.3)	30 (23.6)	5 (17.9)	206 (28.2)	
Magnitude	Slight (10 – 15Δ)	59 (17.0)	49 (21.5)	29 (22.8)	3 (10.7)	140 (19.2)	0.162
	Moderate (20 – 35Δ)	91 (26.2)	73 (32.0)	39 (30.7)	8 (28.6)	211 (28.9)	
	Marked (40 – 90Δ)	197 (56.8)	106 (46.5)	59 (46.5)	17 (60.7)	379 (51.9)	
Ocular motility	Normal	228 (65.7)	181 (79.4)	101 (79.5)	23 (82.1)	533 (73.0)	0.000
	Abnormal	119 (34.3)	47 (20.6)	26 (20.5)	5 (17.9)	197 (27.0)	
Total		347 (47.5)	228 (31.2)	127 (17.4)	28 (3.8)	730 (100)	

Table 3: Causes of esotropia stratified by age groups.

Causes of esotropia	Age Groups (Years), n (%)				All (n = 522)	P-value
	< 6 (n = 298)	6 – 10 (n = 127)	11 – 15 (n = 65)	> 15 (n = 32)		
Refractive errors	142 (47.7)	81 (63.8)	33 (50.8)	15 (46.9)	271 (52.0)	0.003
Congenital	139 (46.6)	44 (34.6)	29 (44.6)	13 (40.6)	225 (43.1)	
Neurological disorders	10 (3.4)	1 (0.8)	1 (1.5)	0 (0.0)	12 (2.3)	0.008
Delayed milestones	7 (2.3)	1 (0.8)	2 (3.1)	4 (12.5)	14 (2.7)	
Role of Heredity						
Negative family history	226 (75.8)	104 (81.9)	51 (78.5)	17 (53.1)	398 (76.2)	0.008
Positive family history	72 (24.2)	23 (18.1)	14 (21.5)	15 (46.9)	124 (23.8)	

Table 4: Causes of exotropia stratified by age groups.

Causes of Exotropia	Age Groups (Years), n (%)				All (n = 208)	P-value
	<6 (n=110)	6 – 10 (n = 50)	11 – 15 (n = 29)	> 15 (n = 19)		
Refractive errors	54 (49.1)	28 (56.0)	15 (51.7)	14 (73.7)	111 (53.4)	0.485
Congenital	51 (46.4)	21 (42.0)	11 (37.9)	5 (26.3)	88 (42.3)	
Neurological disorders	3 (2.7)	0 (0.0)	2 (6.9)	0 (0.0)	5 (2.4)	0.504
Delayed milestones	2 (1.8)	1 (2.0)	1 (4.5)	0 (0.0)	4 (1.9)	
Role of Heredity						
Negative family history	79 (71.8)	39 (78.0)	18 (62.1)	14 (73.7)	150 (72.1)	0.504
Positive family history	31 (28.2)	11 (22.0)	11 (37.9)	5 (26.3)	58 (27.9)	

Table 5: Visual acuity and refractive error among Strabismic patients stratified by age at diagnosis.

Visual Acuity in Decimal Mean (SD) in Different Age Groups (years), n (%)					
	<6 (n = 408)	6 – 10 (n = 177)	11 – 15 (n = 94)	> 15 (n = 51)	
Esotropia	0.70 (0.33)	0.69 (0.34)	0.67 (0.33)	0.74 (0.34)	0.69 (0.34)
Exotropia	0.73 (0.36)	0.87 (0.26)	0.71 (0.41)	0.67 (0.32)	0.78 (0.33)
<i>p</i> -value	0.754	0.001	0.740	0.441	0.032
Refractive Error in Diopter Mean (SD) in Different Age Groups (years), n (%)					
	< 6 (n = 408)	6 – 10 (n = 177)	11 – 15 (n = 94)	> 15 (n = 51)	
Esotropia	3.7 (3.7)	4.1 (4.2)	4.6 (3.3)	2.3 (4.0)	3.9 (3.8)
Exotropia	3.8 (2.6)	2.6 (3.1)	3.1 (3.2)	3.4 (3.7)	3.4 (2.8)
<i>p</i> -value	0.675	0.024	0.024	0.336	0.121

esotropia was the commonest horizontal ocular deviation.^{2,4,5}

The present study showed that females were more affected by strabismus than males, though this difference was not statistically significant. This finding is consistent with the previous studies, which reported that gender was not associated with the type of horizontal strabismus.^{2,15} This study showed that younger patients were associated with an increased probability of having esotropia compared to exotropia. The probable reason for the high proportion of esotropia in children than exotropia might be related to the high amplitudes of accommodation in children as reflected by the high proportion of hypermetropia, which further exacerbates the increased accommodation response. This agrees with Mohney who indicated that esotropia was more prevalent than exotropia in the first six years of life while exotropia became predominant later.¹⁵

Uncorrected RE and congenital factors were the main causes of horizontal strabismus (esotropia and exotropia) in the current study. This is consistent with previous report that the most common form of strabismus was accommodative esotropia.¹⁵ This might be attributed to the strong association between esotropia and uncorrected hypermetropia, in which excessive accommodation associated with hypermetropia could lead to unwarranted accommodative convergence, resulting in esodeviation. Timely management of underlying refractive error is necessary to avoid ocular deviation.

In fact, this study is hospital-based and might reflect referral patterns and eye care utilization behaviour of the community, not representing the true picture of high prevalence of accommodative esotropia among the population. Consequently, preschool and school comprehensive vision screening and a well-controlled community-based study would be needed to assert these findings.

The second leading cause of esotropia was congenital disorders, which refer to an esotropia that occurred earlier than the age of six months (and the study classified it as congenital infantile esotropia). This is in contrast with previous studies which showed that infantile esotropia was one of the most common forms of paediatric strabismus, with an onset within the first six months of life.^{16,17} Earlier studies reported that congenital infantile esotropia commonly associated with anomalies happening at early time in gestation and during the delivery compared to esotropia due to excessive accommodation. These studies^{18,19} propose that ecological background throughout the early development and the method of delivery may have had a greater role in the causes of childhood esotropia than hereditary background.^{16,17} Neurological disorders are considered the third commonest cause of esotropia among children less than six years. This finding agreed with previous report in which the author reported that the risk of neurological disorders is high among children with comitant esotropia.^{18,19} This study revealed that the role of heredity was associated with the occurrence of esotropia ($p < 0.008$). This is in line with the previous studies^{20,21} which showed that the occurrence of esotropia was significantly higher among families with a history of esotropia.

Our study showed that myopia was the leading cause of exotropia in patients more than 15 years of age. This result agrees with Ekdawi et al, who reported that in a population-based study of children with exotropia, myopia was seen in more than 90% of patients by 20 years of age.²⁰ This clarifies the high frequency of exotropia in older patients. However, in fact, the underlying process of uncorrected myopia that leads to the development of exotropia is undefined. Tang, et al assumed that the fusional control at distance vision for patients with myopia was poor as a result of the blurred vision at distance.³

Furthermore, for near vision less accommodation effort is required for a clear image because of a larger accommodation lag, resulting in less accommodative convergence. The reduced convergence may cause failure of the fusional control and might result in development of exotropia.

In the current study, the third leading cause of exotropia was neurological disorders. These results are in line with a previous study, which revealed that the neurologically-induced exotropia was related to hereditary or acquired anomalies of the central nervous system.¹⁵ The present study also showed that the role of heredity was observed in 27.9% of esotropia ($p < 0.504$).

The limitations of the present study include its retrospective design. Patient. This study includes age range of less than 6 years to 15 years, with less than 6 years being the dominant age group. This may have caused bias among other age groups, especially since this group may include nonverbal children.

CONCLUSION

The commonest type of strabismus among Sudanese was esotropia and females were more affected by strabismus, particularly esotropia.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval

The study was approved by the Institutional review board/Ethical review board (Ref: 21-07-10).

REFERENCES

1. **Torp-Pedersen T, Boyd HA, Skotte L, Haargaard B, Wohlfahrt J, Holmes JM, et al.** Strabismus incidence in a Danish population-based cohort of children. *JAMA Ophthalmol.* 2017;**135**(10):1047-1053. Doi: 10.1001/jamaophthalmol.2017.3158.
2. **Olusanya BA, Ugalahi MO, Ayeni O, Fawole OI, Baiyeraju AM.** Common Forms of Strabismus in a Tertiary Eye Clinic in Southwest Nigeria. *Niger J Ophthalmol.* 2019;**27**(2):62-67. Doi: 10.4103/njo.njo_8_19.
3. **Tang SM, Chan RY, Lin SB, Rong SS, Lau HH, Lau WW, et al.** Refractive errors and concomitant strabismus: a systematic review and meta-analysis. *Sci Rep.* 2016;**6**(1):35177. Doi: 10.1038/srep35177.
4. **Anand N, Gupta J, Gupta R.** Study of clinico-etiological profile of patients with paralytic and restrictive strabismus. *IP Int J Ocul Oncol Oculoplasty.* 2020;**6**(1):48-54. Doi:10.18231/j.ijoo.2020.009.
5. **Chia A, Roy L, Seenyen L.** Comitant horizontal strabismus: An Asian perspective. *Br J Ophthalmol.* 2007;**91**(10):1337-1340. Doi:10.1136/bjo.2007.116905.
6. **Alrasheed SH, Naidoo KS, Clarke-Farr PC.** Prevalence of visual impairment and refractive error in school-aged children in South Darfur State of Sudan. *Afr Vis Eye Health.* 2016;**75**(1):1-9. Doi:10.4102/aveh.v75i1.355.
7. **Taha AO, Ibrahim SM.** Prevalence of manifest horizontal strabismus among basic school children in Khartoum City, Sudan. *Sudanese J Ophthalmol.* 2015;**7**(2):53-57. Doi:10.4103/1858-540X.169437.
8. **Akpe BA, Dawodu OA, Abadom EG.** Prevalence and pattern of strabismus in primary school pupils in Benin City, Nigeria. *Nigerian J Ophthalmol.* 2014;**22**(1):38-43. Doi: 10.4103/0189-9171.142755.
9. **Greenberg AE, Mohny BG, Diehl NN.** Clinical characteristics of childhood strabismus from a population-based cohort. *J AAPOS.* 2007;**11**(1):89-90. Doi: 10.1016/j.jaapos.2006.11.094.
10. **Alrasheed SH.** Clinical Characteristics of Patients Presenting with Headache at Binocular Vision Clinic: A Hospital Based Study. *Pak J Ophthalmol.* 2020;**36**(3):247-252. Doi: 10.36351/pjo.v36i3.1046.
11. **Elabdeen RH, Ibrahim SM.** Clinical Study of Vertical Strabismus among Patients Attending Squint Clinic–Makkah Eye Hospital–Khartoum. *Int Res Med Health Sci.* 2019;**2**(1):1-9. Doi:10.36437/irmhs.2019.2.5.U.
12. **Robaei D, Rose KA, Kifley A, Cosstick M, Ip JM, Mitchell P.** Factors associated with childhood strabismus: findings from a population-based study. *Ophthalmology.* 2006;**113**(7):1146-1153. Doi: 10.1016/j.ophtha.2006.02.019.
13. **McKean-Cowdin R, Cotter SA, Tarczy-Hornoch K, Wen G, Kim J, Borchert M, et al.** Prevalence of amblyopia or strabismus in Asian and non-Hispanic white preschool children: multi-ethnic pediatric eye disease study. *Ophthalmology.* 2013;**120**(10):2117-2124. Doi: 10.1016/j.ophtha.2013.03.001.
14. **Govindan M, Mohny BG, Diehl NN, Burke JP.** Incidence and types of childhood exotropia: a population-based study. *Ophthalmology.* 2005;**112**(1):104-108. Doi: 10.1016/j.ophtha.2006.01.038.
15. **Mohny BG, Greenberg AE, Diehl NN.** Age at strabismus diagnosis in an incidence cohort of children. *Am J Ophthalmol.* 2007;**144**(3):467-469. Doi: 10.1016/j.ajo.2007.04.022.

16. **Dotan G, Keshet Y, Qureshi HM, Friling R, Yahalom C.** When paediatric acute acquired comitant esotropia is not caused by a neurological disease. *J AAPOS.* 2020;**24(1)**:1-5.
Doi: 10.1016/j.jaapos.2019.09.016.
17. **Shaaban S, Matsuo T, Fujiwara H, Itoshima E, Furuse T, Hasebe S, et al.** Chromosomes 4q28.3 and 7q31.2 as New Susceptibility Loci for Comitant Strabismus. *Invest. Ophthalmol. Vis. Sci.* 2009;**50(2)**:654-661. Doi: org/10.1167/iovs.08-2437.
18. **Chaudhuri Z, John J, Aneja S, Thelma BK.** Pedigree Analysis of Familial Primary Concomitant Horizontal Strabismus in Northern India. *Strabismus.* 2017;**25(4)**:200-213.
Doi: 10.1080/09273972.2017.1350865.
19. **ÇorakEroğlu F, Oto S, Şahin Fİ, Terzi Y, Özer Kaya Ö, Tekindal MA.** The Role of Heredity and the Prevalence of Strabismus in Families with Accommodative, Partial Accommodative and Infantile Esotropia. *Turk J Ophthalmol.* 2020;**50(3)**:143-150.
Doi:10.4274/tjo.galenos.2019.49204. PMID: 32631000; PMCID: PMC7338743.
20. **Ekdawi NS, Nusz KJ, Diehl NN, Mohny BG.** The development of myopia among children with intermittent exotropia. *Am J Ophthalmol.* 2010;**149(3)**:503-507. Doi:10.1016/j.ajo.2009.10.009.
21. **Mohny BG, Huffaker RK.** Common forms of childhood exotropia. *Ophthalmology.* 2003;**110(11)**:2093-2096.
Doi:10.1016/j.ophtha.2003.04.001.

Authors' Designation and Contribution

Saif Hassan Al-Rasheed; Associate Professor:
Concepts, Design, Literature Search, Data Acquisition, Data Analysis, Statistical Analysis, Manuscript Preparation, Manuscript Editing, Manuscript Review.

