

Latent Convergent Strabismus Clinical Features and Management in Sudanese Patients



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ABSTRACT

Purpose: To describe the clinical features and management of latent convergent strabismus among Sudanese patients.

Study Design: Descriptive observational study.

Place and Duration of Study: Makkah Eye Complex, Khartoum, Sudan, from December 2018 to August 2020.

Methods: The study included 137 patients, diagnosed with latent convergent strabismus (esophoria). Demographic data and ocular examination findings including visual acuity, refractive error, and degree of esophoria was collected. Esophoria was assessed by prism cover test (PCT) at near and distance.

Results: Esophoria was more common among females (n=107, 78.1%) and in age group 15 to 25 years. Headache was the most common complaint (n=64, 46.7%). Most of the patients (n=114, 83.2%) had 1 to 5 Δ of esophoria with a mean of 4.17±2.99Δ. Majority of the patients (n=132, 96.3%) had normal near point of convergence (NPC) 6.98±3.10 cm. Positive fusional vergence (PFV) was high at 24.06±9.01Δ, whereas negative fusional vergence (NFV) was low at 5.0±0.21ΔD, P=0.001. Majority of the patients (76.6%) responded well to the refractive correction, 11.7% patients to vision therapy and remaining 11.7% to both refractive correction and vision therapy. Correlation coefficients revealed that there was a positive correlation between, refraction, NPC and PFV (P > 0.05).

Conclusion: Esophoria was more common among females and young adults. Most of the esophoric patients had uncorrected hyperopia, good PFV and relatively poor NFV amplitude. Early detection and management of young esophoric patients is essential to improve vision and binocular functions.

Key Words: Latent Strabismus, Esophoria, Exophoria, Myopia, Hyperopia.

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INTRODUCTION

Latent convergence strabismus or esophoria is a binocular disorder in which the eyes tend to converge in the absence of fusional vergence.^{1,2} The condition

was classified by Duane regarding to whether the convergence is greater for distance (divergence weakness) or near (convergence excess) or if it remains consistent for both(mixed).¹ It is commonly prevalent in childhood and usually occurs because of overstimulation of the accommodative convergence during near activities.^{3,4} Asthenopic symptoms such as poor concentration, ocular fatigue, diplopia, eye strain and headache have been found to be associated with increase of near esophoria, which is correlated with higher levels of accommodative convergence.⁵

Esophoria is typically associated with accommodative problems, where it primarily arises

from an overactive accommodation response caused by uncorrected hyperopia or prolonged near work.⁶ Due to the interconnected relationship between accommodation and convergence, excessive accommodation leads to an excessive convergence response.¹ Conversely, some latent convergence strabismus does not have relation with this accommodative aspect and this type is called non-accommodative esophoria. It can be due to a mixture of mechanical, anatomical and innervation factors.^{1,6} Various factors can influence anatomy of eyes, including eye position, orbit size and shape and the amount of fat tissue within the orbit. Additionally, mechanical factors play a role and involve the actions of the extraocular muscles responsible for eye movements. Innervational factors refer to the neural impulses that guide eye movements. Certain diseases can impact fusion, such as uncorrected refractive errors, cataract and optic neuropathies may result in decompensated esophoria.^{6,7}

Fusional vergence is responsible for controlling the tendency of eyes to deviate from binocular fixation, thus esophoria is controlled by Negative Fusional Vergence (NFV).^{1,4,8} It is stated that the NFV to the blur point, should be at least twice the size of the esophoria to overcome symptoms.^{9,10}

Management of esophoria can involve different approaches. One method is to correct any hyperopia using spherical lens correction. Another approach is orthoptic training, which aims to improve NFV. Additionally, prism correction in the base-out direction can be utilized as a form of treatment.¹¹ The ultimate aim of the management of latent convergence strabismus and other binocular disorders related to esophoria is to improve the patient's ability to maintain fusion when converging and diverging at near and distance fixation. As mentioned above there is no study conducted in Sudan to assess the clinical features and treatment options of esophoria among Sudanese patients seeking treatment. Therefore, this study was performed to assess the clinical characteristics and management for latent convergent strabismus among Sudanese patients.

METHODS

This descriptive retrospective hospital-based study analysed medical records of 137 patients, diagnosed with esophoria at Makkah Eye Complex, Khartoum, Sudan, from December 2018 to August 2020. The

study excluded records that were missing essential information. Ethical approval was received from the Biomedical Ethics Committee at Al-Neelain University, Sudan (Approval No. 18-09-12). The research was carried out in accordance with the principles outlined in the Declaration of Helsinki.

In this study, a non-probability sampling technique was employed to select 137 patient records from Makkah Eye Complex, Khartoum, Sudan. Age of the participants ranged from 5 to 45 years and the sample consisted of 30 males and 107 females. Demographic data included personal history, ocular symptoms and age of the patients. Distance visual acuity was evaluated using Snellen tumbling E-chart, while refractive errors were determined utilizing the Neitz RX Retinoscope. Esophoria was assessed by prism cover test (PCT) and Maddox Wing at near and distance fixation. The degree of latent deviation was categorized as follows; slight as less than 10Δ , moderate as 10 to 20Δ and marked as more than 20Δ . The ocular motility test involved evaluating eye movement and muscle action by using a fixation target positioned at near and then moving it to nine different positions of gaze. The near point of convergence (NPC) was measured by using RAF (Royal Air Force Rule). The PFV and NFV were determined utilizing a prism bar at a distance of 40 cm. The prism bar was gradually moved at a rate of approximately one step every two seconds until reaching the "blur point," where the object of focus becomes blurry. Following this, the prism power was gradually increased until the "breakpoint" (the point at which fixation object appears double). The prism power at which the patient was unable to fuse the target was recorded as the breakpoint.

Data was initially recorded in a Microsoft Excel 2016 spreadsheet. Subsequently, statistical analysis was carried out using the SPSS 25.0 developed by IBM Corp. in Armonk, New York, USA. Prior to conducting the analysis, the data underwent a thorough examination to identify any input errors or missing values. Descriptive analyses, such as determining frequencies, proportions, means and standard deviations of the data, were performed. Statistical significance was assessed with a threshold of p value less than 0.05.

RESULTS

The study showed that most of the esophoric patients were young adults (n=58, 42.3%), age between 15 –

Table 1: Demographic, clinical characteristics and symptoms of the esophoric patients

Characteristic	N (%)	p-value
Gender		
Male	30(21.9)	P= 0.001
Female	107(78.1)	
Age (Years) Mean \pmSD	18.81\pm7.66	
5-15	46(33.6)	P=0.001
15-25	58(42.3)	
25-35	26(19.0)	
35-45	7(5.1)	
Visual Acuity (Decimal)	RE Mean \pm SD = (0.97 \pm 0.1)	LE Mean \pm SD= (0.97 \pm 0.09)
Refractive error (Diopter)	RE Mean \pm SD = (0.55 \pm 0.49)	RE Mean \pm SD = (0.58 \pm 0.57)
Ocular complaints		N (%)
Headache		64(46.7)
Ocular pain		47(34.3)
Difficulty to read		16(11.7)
Intermittent diplopia		7(5.1)
Excessive blinking		3(2.2)
Total		137(100)

25 years and 46(33.6 %) patients were children whose age ranged from 5 – 15 years. This indicated that esophoria is more common among young adults. The association between esophoria and age of the patient was highly significant with $p= 0.001$. Regarding gender distribution, esophoria was more common among females ($n=107, 78.1\%$) and the difference was statistically significant ($p=0001$). Visual Acuity was 0.97 ± 0.1 and 0.97 ± 0.09 for the right and left eyes respectively.

Majority of the esophoric patients, ($n=118, 86.1\%$) had uncorrected hyperopia less than 1.00D and only 19(31.9%) had uncorrected hyperopia more than 1.00D.

Concerning ocular complaints, headache was more common among esophoric patients ($n=64, 46.7\%$) followed by ocular pain ($n=47, 34.3\%$) as shown in Table 1.

Measurement of esophoria by prism alternating cover test showed that 118(86.1%) patients had slight esophoria, 17(12.4%) had moderate esophoria and only 2(1.5%) had marked esophoria. The measurement of the degree of esophoria at near fixation showed

that most of the patients ($n=114, 83.2\%$) had 1 – 5 Δ with a mean of $4.17\pm 2.99\Delta$ as shown in Table 2.

Majority of the esophoric patients, ($n=132, 96.3\%$) had normal NPC (6-10 cm). Only 2(1.5%) patients had NPC less than 6 cm. Mean NPC was 6.98 ± 3.10 cm. Regarding fusional vergence, most of the esophoric patients ($n=119, 86.9\%$) had NPF vergence. Only 18(13.1%) patients had PFA less than 15 prism diopter with mean of $24.06\pm 9.01\Delta$ D. The NFA was slightly low among esophoric patients with mean of $5.0\pm 0.21\Delta$ D. The difference between positive and negative fusional amplitude was highly significant $p=0.0001$ as illustrated in Table 3.

Majority of the patients ($n=105, 76.6\%$) responded well to the refractive correction as shown in Table 4.

Correlation coefficients revealed that there was a weak negative correlation between visual acuity and near esophoria but not statistically significant $p > 0.05$. Conversely, there was a positive correlation between, refraction, NPC, NFV and PFV but not statistically significant $p > 0.05$ as shown in Table 5.

DISCUSSION

The present study aimed to provide the clinical characteristics and treatment options for the patients with latent convergence strabismus who attended Makkah Eye Complex in Khartoum, Sudan. Previously published studies revealed that the clinical features for binocular vision disorders differs from one community to another.^{12,13} It is essential to have knowledge about latent convergence strabismus as it is

Table 2: Estimation and measurement of esophoria by PCT.

Estimation of Near Esophoria	N (%)	Measurements of Near Esophoria	
			N (%)
Slight < 10 Δ	118 (86.1%)	1-5 Δ	114(83.2)
Moderate 10-20 Δ	17(12.4%)	7-11 Δ	19(13.9)
Marked > 20 Δ	2(1.5%)	13-15 Δ	4 (2.9)
Total	137(100%)	4.17\pm2.99Δ	137(100)

Table 3: Distribution of Near Point of Convergence and fusional vergence among esophoric patients.

Near Point of Convergence (NPC)		N (%)	
Less than 6 CM		2(1.5%)	
6-10 CM		132(96.3%)	
More than 10 CM		3(2.2%)	
Mean \pm SD		6.98 \pm 3.10 cm	
Positive Fusional vergence	N (%)	Negative Fusional Vergence	N (%)
less than 15 Δ	18(13.1)	less than 5 Δ	3(2.2)
15-45 Δ	119(86.9)	5-15 Δ	134(97.8)
Mean \pm SD	24.06 \pm 9.01 Δ	Mean \pm SD	5.0 \pm 0.21 Δ
Total		137(100%)	

Table 4: Type of management.

Type of Management	N (%)
Refractive correction	105(76.6)
Vision therapy	16(11.7)
Both management	16(11.7%)
Total	137(100%)

Table 5: Correlation coefficients between esophoria at near and the clinical parameter.

Esophoria at near fixation n=137(4.17 \pm 2.99 Δ)			
Parameter	Mean \pm S. D	Correlation	P-value
Age (years)	18.81 \pm 7.66	0.054	0.534
VA RE(Decimal)	0.97 \pm 0.10	-0.26	0.76
VA LE(Decimal)	0.97 \pm 0.09	-0.02	0.83
Refraction RE(D)	0.55 \pm 0.49	0.04	0.62
Refraction LE(D)	0.58 \pm 0.57	0.05	0.59
NPC (cm)	6.98 \pm 3.10	0.04	0.66
PFV (Prism dioptre)	24.06 \pm 9.01	0.10	0.30
NFV (Prism dioptre)	5.0 \pm 0.21	0.12	0.20

VA= Visual acuity; D= Dioptre; NPC= near point of convergence; PFV= Positive Fusional Vergence; NFV= Negative Fusional vergence.

more common among children. The findings of the current study showed that esophoria was more predominant among females, $P=0.001$ and age group 15 to 25 years, $P= 0.001$. The more common ocular symptom was headache and ocular pain. Whereas, most of the patients had small degree of esophoria 4.17 \pm 2.99 Δ , majority of the patients had normal NPC. Additionally, PFV was high at 24.06 \pm 9.01 Δ , whereas NFV was low at 5.0 \pm 0.21 Δ , $P=0.001$. Regarding the treatment most of patients responded well to the refractive correction and vision therapy. Correlation coefficients revealed that there was a positive

correlation between, refraction, NPC and PFV $P > 0.05$.

In contrast to our finding, previous studies revealed that gender was not associated with types of binocular vision disorders.^{14,15} We assumed that a high percentage of latent convergence strabismus found among females may be due to narrow spaces between two eyes or small interpapillary distance than males. This anatomical factor may lead to convergence excess esophoria. The present study showed that esophoria is more common among young adults, the association was highly significant $p=0.001$. This could be due to the young age associated with very active accommodation which leads to high convergence. A high prevalence of esophoria among young age could be due to prolonged use of smart devices such as computers and smartphones as mentioned in previous studies.^{12,16}

Our findings showed that headache was a common ocular symptom among esophoric patients followed by ocular pain. This might be due to excessive neuromuscular innervation which leads to high accommodative convergence or AC/A ratio. The mean of visual acuity in decimal readings was 0.97 \pm 0.1 and 0.97 \pm 0.09 for the right and left eyes respectively. This indicated that most of patients with latent convergence strabismus had good vision. This could be due to fact that hyperopia is commonly associated with esophoria.

Majority of the esophoric patients had normal NPC (6.98 \pm 3.10 cm). PFV was high, while NFV was low among esophoric patients with $p=0.000$. Most of the esophoria was convergence excess type associated with a high positive fusional reserve and lack of negative fusional amplitude. Correlation coefficients revealed that there was a weak negative correlation between visual acuity and near esophoria $p>0.05$. Conversely, there was a positive correlation between, refraction, NPC, NFV and PFV $p > 0.05$.

Limitations of the study are retrospective design and single center hospital based study.

CONCLUSION

Esophoria was more common among females and young adults, particularly the convergence excess type. Most of the esophoric patients had uncorrected hyperopia, good positive fusional vergence and relatively poor negative fusional vergence amplitudes. Therefore, early detection and management of young esophoric patients with optical correction and vision

therapy are essential to improve vision and binocular functions.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board (Ref No. 18-09-12).

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Authors' Designation and contribution

Aisha Hassan Osman; Optometrist: *Concepts, Design, Literature Search, Data Acquisition, Data Analysis, Manuscript Review.*

Saif Hassan Alrasheed; Associate Professor: *Concepts, Design, Literature Search, Data Analysis, Manuscript Preparation, Manuscript Editing, Manuscript Review.*

