Original Article

Measurement of Horizontal Fusional Reserves Among Myopic Children

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ABSTRACT

Purpose: To investigate the horizontal fusional vergence among school going myopic children by measuring the positive fusional vergence and negative fusional vergence break point at nearby.

Study Design: Cross-sectional study

Place and Duration of Study: Fatima memorial hospital Lahore, from December 2023 to March 2024.

Methods: A total of 60 school-going myopic children aged 5 to 16 years were recruited. Participants were selected using a non-probability consecutive sampling technique, based on predefined inclusion criteria. A comprehensive clinical evaluation was performed, including assessment of visual acuity, strabismus testing, and measurement of the near point of convergence (NPC) using the RAF rule. Fusional vergence ranges were measured at near using a prism bar and a near picture target. Positive fusional vergence (PFV) and negative fusional vergence (NFV) were both assessed with the prism bar. The Chi-square test was applied to determine associations between categorical variables.

Results: Among the participants, 83.3% had normal convergence amplitude, 3.3% demonstrated convergence excess, and 13.3% had convergence insufficiency. There was no statistically significant association between myopia and positive fusional vergence (p = 0.831). Divergence amplitude assessment revealed that 93.4% had normal divergence amplitude, while 6.67% exhibited divergence insufficiency; no cases of divergence excess were observed. Similarly, no statistically significant association was found between myopia and negative fusional reserve (p = 0.52).

Conclusion: Myopia appears to have minimal impact on horizontal fusional vergence in school-going children.

Keywords: Myopia, Fusional Reserves, Positive fusional vergence, Negative fusional vergence.

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INTRODUCTION

Vergence dysfunction is a binocular disorder in which the amplitude of both positive fusional vergence(also known as convergence) and negative fusional vergence(also known as divergence) is reduced but individuals mostly have normal limits of both distant and near phoria and normal AC/A ratio.[1] Measuring horizontal fusional reserves is a valuable diagnostic tool for identifying and tracking vergence disorders, including convergence insufficiency, which can lead to eye strain (asthenopia) and impair near vision tasks, such as reading and computer work.[2] In clinical settings, fusional vergence range is frequently assessed to determine a patient's binocular state and capacity to correct asthenopia associated with the condition. Individuals struggle with near vision tasks due to inadequate vergence or accommodative ability resulting in eye strain. Hence, an accurate diagnosis and effective management of fusional vergence dysfunction (FVD) are crucial aspects of optometric care, highlighting the need for practitioners to prioritize this condition to ensure optimal patient outcomes. Several investigations are conducted to determine the average normal range of binocular function across various populations.[2,3] Pediatric population is of great interest regarding fusional vergence because of increased near work in school

going children. Near point of convergence, and fusional vergence are assessed to identify the binocular vision anomalies in these children.[3,4]

Myopia is among the most common ocular disorders worldwide, with a particularly rapid rise in prevalence across Asian countries.[5] In Pakistan, its prevalence has been reported as 36.5% in adults and 42.2% in children.[6] Prolonged near-work activities such as reading, studying, writing, using digital devices, and watching television at close distances are considered important risk factors.[7] The increased accommodative demand during such tasks may contribute to the onset and progression of myopia, particularly during school years. Excessive near work can also reduce fusional vergence, leading to asthenopia, headaches, eyestrain, and difficulty sustaining focus.[8,9] Asthenopia may further arise from uncorrected refractive errors or binocular vision anomalies, including horizontal phoria and fusional vergence dysfunctions.[10,11]

Assessment of binocular vision (BV) is a vital component of evaluating visual function. More than 80% of perceptual input is processed through the visual system, making the role of vergence function critical for cognitive development and academic performance in children. Efficient near-work performance, particularly in school-going children, depends heavily on intact binocular vision; any disruption can adversely affect tasks such as reading and writing.[12] Several studies have investigated parameters such as near point of convergence (NPC) and fusional vergence in school-aged children across different populations.[11,12] However, there is scarce data from Pakistan particularly among myopic children, despite the global surge in myopia prevalence.[13]

The primary objective of this study is to determine the association between myopia and fusional vergence, with specific focus on the distribution of positive and negative fusional vergence among school-going Pakistani children. Secondly, the study reports the frequency of non-strabismic vergence anomalies in this group.

METHODS

This single-center cross-sectional study was conducted in outpatient department of Ophthalmology Fatima Memorial hospital of medicine and dentistry, Lahore from December 2023 to March 2024 over a period of 4 months after taking approval from the institutional review board **(FMH-08/09/2023-IRB-1307)**.

A written or verbal parental consent and subject approval was taken from all the subjects prior to conducting any study procedures. A total of 60 myopic school going children, ages ranging from 5 to 16 years, were recruited through nonprobability consecutive sampling. Children with squint and amblyopia and those who presented with any other type of refractive error were excluded.

Prior to eye examination, each participant was informed about the purpose and procedure of the technique**.** Data included age, gender, duration of myopia and family history of myopia by using a self-designed proforma. Clinical examination included visual acuity with and without glasses using Snellen's vision chart, lensometry of already prescribed glasses, Hirschberg, cover-uncover test, cycloplegic refraction (for the age group of 5 to 10 years), non-cycloplegic refraction (for the age above 10 years). Subjective refraction was performed later to attain a standard level of best corrected visual acuity.

Binocular dysfunction was assessed by measuring NPC and vergence amplitude. The near point of convergence was measured by RAF ruler. The subjects were asked to fixate on a small target on RAF ruler. The NPC was recorded where the participant reported double image, or objectively when fusion was lost and one of the eyes deviated if the subject did not report any double image. The procedure was conducted thrice, and midpoint of 3 break points was noted for analysis.

A prism bar was used to measure fusional vergence ranges by presenting a near picture target. A picture target was presented to the subject and over one eye horizontal prism bar was placed. The prism power increased gradually until the child reported diplopia.

The subject was instructed to indicate the single image (recovery point) achieved upon regaining fixation, which occurred as the prism power decreased. The break point was determined objectively when fixation was lost, if the subject had not reported diplopia, and was recorded as the limit of fusional vergence. Near fusional vergence testing was performed three times, and the mean of the three measurements was used for analysis. The sequence of testing was base-in (BI) followed by base-out (BO), as the convergence response elicited during positive fusional vergence may induce tonic vergence

adaptation, potentially biasing subsequent results. The data was collected and analyzed using IBM-SPSS v-25 software. Frequency and percentage were presented for qualitative variables like age and gender. Mean and SD were calculated for quantitative variables like, NPC, positive fusional vergence break point and negative fusional vergence break point. Chi-square test was employed for analysis. The level of significance was fixed at 0.05 for each analysis.

RESULTS

This study included 60 subjects. The frequency of female subjects was 58.3% while male subjects was 41.7%. The mean age was 11.92±2.82(range 5 to 16 years). Among all the participants, 43.3% presented with mild myopia (-0.25D to < -2D), 48.3% presented with moderate myopia (-2D to 6D) and 8.3% presented with high myopia(>6D). The following table shows the mean value of NPC and break point of fusional vergence in prism diopter.

Table 1: *Mean values of NPC and fusional vergences (n=60).*

Parameter	Mean ± SD
NPC in cm	1.02±0.13
Negative fusional break in prism diopter	12.30±1.03
Positive fusional break in prism diopter	25.12±3.39

Positive fusional vergences were measured in all the enrolled participants. The results of convergence amplitude measurement showed that 83.3% of individuals had a normal convergence amplitude (20pd to 30pd) while 13.3% presented with convergence insufficiency (<20pd) and only 3.3% presented with convergence excess(>30pd). NPC was within the normal limits in this study. The distribution of positive fusional vergence amplitude is shown in Table 2. The negative fusional vergences was also measured in all the enrolled participants. The results showed that 93.4% had divergence amplitude within the normal range (12PD to 14PD) while 6.67% had divergence insufficiency(<12PD). The frequency distribution of negative fusional vergence amplitudes found in myopic subjects is shown in Table 2.

DISCUSSION

Excellent visual acuity and efficient binocular function play a vital part in academic excellence and educational achievement. Research has shown that children with excellent vision and binocular function tend to perform better in learning activities, suggesting a strong link between visual abilities and academic achievement.[14,15] Vergence dysfunction in myopic school going children has a detrimental impact on academic performance, hindering students' ability to reach their full potential.

It has been reported that myopia is associated is vergence anomalies and it influences vergence dysfunction.[16] A study conducted by Jung Un Jang in South Korea on myopic children to find out the distribution of near vergence suggested that there was no statistically significant correlation between myopic magnitude and fusional vergence.[17] The results of our study are consistent with the previous study and it depicts that myopia has quite a low impact on convergence amplitude and divergence amplitude in school going myopic children as most of the subjects have their convergence and divergence amplitude ranges within the normal limits. However, there are studies which show that convergence insufficiency had a higher proportion among all the vergence abnormalities in myopic population.[18-20] It has been observed in our study that convergence insufficiency was more common than other types of vergence dysfunction. The highest frequency of convergence insufficiency was observed in moderate myopia 17.2%, followed by mild myopia 11.5%. The highest frequency of divergence insufficiency was also

Table 2: *Distribution of positive and negative fusional vergences amplitude according to severity of refractive error.*

		Mild Myopia	Moderate Myopia	Severe Myopia	Total	p value
Positive Fusional Vergences	Normal convergence amplitude	22	23	5	50	0.83
	Convergence Insufficiency	3	5	0	8	
	Convergence Excess	1	1	0	2	
	Total	26	29	5	60	
Negative Fusional Vergences	Normal Divergence amplitude	25	26	5	56	0.52
	Divergence Insufficiency	1	3	0	4	
	Divergence excess	0	0	0	0	
		26	29	5	60	

observed in moderate myopia 10.34%, followed by mild myopia 3.84%.

This study had several limitations. First, the relatively small sample size and single-center design may limit the generalizability of the findings to broader populations. The participants were recruited using a non-probability consecutive sampling technique, which may introduce selection bias. Third, the cross-sectional nature of the study precludes establishing a causal relationship between myopia and fusional vergence. Additionally, only school-going children were included, and factors such as accommodative function, and time spent on near work were not analyzed in depth, which may influence fusional vergence. Finally, measurements were based on clinical techniques that can be influenced by examiner skill and patient cooperation, especially in younger children.

CONCLUSION

There was quite low association between myopia and horizontal fusional vergences. Further studies are needed to find out effects of myopia on horizontal fusional reserves among Pakistani school going children.

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Patient's Consent: Researchers followed the guide lines set forth in the Declaration of Helsinki.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board **(FMH-08/09/2023-IRB-1307)**.

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Authors Designation and Contribution

Ramla Yaseen; Optometrist: *Concepts, Design, Data Acquisition, Data Analysis, Manuscript Preparation, Manuscript Editing.*

Tajallah Arshad; Optometrist: *Concepts, Literature Search, Statistical Analysis.*

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