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Fusional Vergence amplitude measurement among students of ISRA School of optometry, Isra University, Karachi campus

Abstract

Purpose: To determine mean fusional vergence amplitudes FVA and the effect age and gender on FVA.

Methodology: A cross sectional descriptive study was conducted among Isra School of optometry, Isra University, Karachi campus students from August 2023 to December 2023. A total of 120 students consisting of 43 males (35.8%) and 77 females (64.1%) were recruited using a convenient sampling technique. Inclusion criteria included subjects with 6/6 vision, no any ocular disease, strabismus and subjects with exophoria or esophoria. The age ranged from 18-27 years. Patients underwent ophthalmic procedure i.e. visual acuity for both distance and near and ophthalmoscopy was performed to check the clarity of the patient's media. After assessing the ocular media, cover test was used to check the type of phoria. By using horizontal prism bars, Positive Fusion Vergence (PFV) and Negative Fusion Vergence (NFV) were recorded as break, and recovery points at near and distance. All the information was recorded in self-made Performa. Data was analyzed using SPSS.

Result: Students were categorized into three age groups: Group 1 (18-21 years), Group 2 (22-24 years), and Group 3 (25-27 years). The data showed negative fusional divergence break-up and recovery points at distance and near, with mean values of 10.06±4.8 Δ and 7.3±4.7 Δ, respectively. Positive fusional convergence break-up and recovery points at distance and near had mean values of 10.95±6.11 Δ and 8.1±5.57 Δ, respectively. The result for negative divergence break and recovery point at distance were significant with p-value of 0.021 and 0.026, respectively

Conclusion: This study concluded that the mean fusional vergence amplitudes FVA at near and distance are reduced while distance and near FV revealed no effects of age and gender. However, negative fusional break point and positive fusional recovery point were significantly affected by age.

Keywords: fusional Vergence amplitudes, binocular single vision, Isra school of optometry

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Introduction

Fusion amplitudes (also known as vergences) are the result of a motor response triggered by sensory input and ability of eyes to converge or diverge for maintaining binocular single vision (BSV) caused by images of the subject of attention moving out of one fovea resulting in disparity.[1,2] Good fusional amplitudes are crucial for binocular vision stability and plays a significant role in enabling accurate depth perception. Whilst vergence system abnormalities can cause a wide range symptoms that affect academic performance and visual comfort.[3,4] Fusion vergence is important to maintain a comfortable single vision and to avoid diplopia.[5,6]

When examining a symptomatic patient, one of the most vital tools available to us as clinician is measuring the range of fusional vergences. Various techniques are employed by different sources to assess horizontal fusional ranges.[7,8] Prism bar, rotary prism and amblyoposcope are used to evaluate prism fusion range. The prism bar vergence facility test and step vergence facility test are served as valuable methods in assessing a patient's binocular vision and identifying potential problems related to fusional vergence.[2] It is helpful to treat ocular misalignment by evaluating fusional vergence amplitudes.[9,10] Gender and refractive errors don't impact on fusional vergence dysfunction.[11]

Horizontal vergence movements occur to maintain BSV when base-out and base-in prisms are introduced in front of eye. The prism fusion amplitude represents the maximum strength of prism that can be fused effectively: the positive amplitude is evaluated by base-out prisms, while the negative amplitude is assessed using base-in prisms.[12] The typical range for negative fusional vergence break-up point is 12–23Δ, with a recovery point between 8 to 17 Δ. Positive fusional vergence break-up point ranges from 16 to 35 Δ, with a recovery point between 11 and 24 Δ.[13] This study determined the mean value of fusional vergence amplitude for near and distance and the effect of age and gender on fusional vergence among the students of ISRA School of Optometry, Isra University, Karachi campus.

Methodology

From July to December 2023, a hospital-based cross-sectional Descriptive study was undertaken among students at ISRA School of optometry, Isra University, Karachi campus utilizing a non-probability convenient sampling technique. The Isra Postgraduate Institute of Ophthalmology's (IPIO) Research Ethical Committee (REC) granted ethical approval. A sample of 120 was calculated by Rao Soft sample calculator by using population size of 174 (total no. of students) by keeping 95% confidence interval and 5% margin of error.

Subjects age ranged from 18-27 years with VA 6/6 with or without correction, Orthophoric, exophoric or esophoric, Both Gender either male or female, No previous history of ocular surgery and binocular vision disorder were included. While subjects with amblyopia, eye infections, vertical Heterophoria, strabismus, corneal abnormalities and other corneal pathologies, systematic disease diabetes and hypertension were excluded.

The protocol for examination for all subjects who fulfilled our inclusive criteria at Isra School of Optometry were included. Informed consent was obtained and confidentiality of the given information was guaranteed. Visual Acuity was recorded separately for both distance and near. Ophthalmoscope was used to check the media clarity of the patient then the type of horizontal phoria was confirmed by using cover test. Prism cover test (PCT) was performed to measure phoria whilst Fusional vergence amplitudes were measured by using prism bar at near and distance. Fusional divergence amplitudes were measured first with Base-In prism followed by fusional convergence amplitudes with Base-Out prism. Data was collected on self-prepared proforma. In order to meet the study's goals, the obtained data was analyzed using the statistical package for social science (SPSS). The mean of all quantitative variables were reported. A frequency and percentage is displayed for each qualitative variable. One way ANOVA test was applied to see whether fusional vergence amplitudes (FVA) depend on age. A p-value of <0.05 was considered significant. Independent sample t-test was used to reveal whether FVA is affected by gender.

Results

120 students in all, met the study's inclusion requirements, 43 of whom were males and 77 of whom were females. The mean age of the sample was 21.39 years. Students were categorized into three groups according to age. Group 1 (18-21years) which included 67 (56%) students, Group 2 (22-24 years) had 48 (40%) students, and Group 3 (25-27 years) had 5 (45%) students as shown in Figure 1.

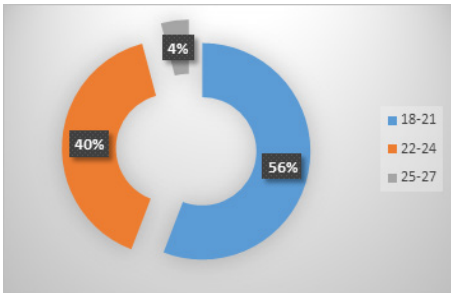

Figure 1 Donut pie chart show the frequency of different age groups.

A cross tabulation between age groups and latent strabismus showed there were 54, 37 and 3 orthophoric students in Group 1, Group 2 & Group 3, respectively. There were 12, 9 and 2 exophoric students in Group 1, Group 2 & Group 3 respectively. While 1 and 2 esophoric students in age Group 1 & Group 2, respectively as shown in Figure 2.

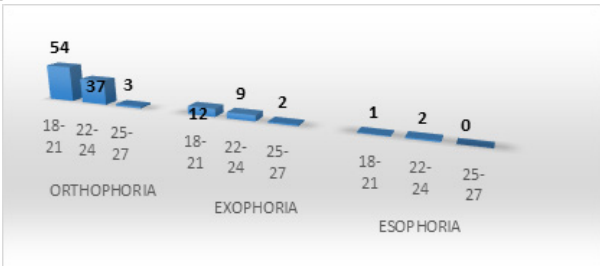

Figure 2 Frequency of Latent strabismus age-wise.

Exophoria was categorized into three types; convergence weakness, divergence excess and non-specific.[14] There were 0 convergence weakness, 2 divergence excess and 0 non-specific students in Age group 3. There were 3 convergence weakness, 5 divergence excess and 01 non-specific students in age Group 2 while 5 convergence weakness, 6 divergence excess and 01 non-specific students in age Group 1 as shown in Figure 2.

Esophoria was categorized into three types; convergence excess, and non-specific[13]. There were 1 convergence excess and 1 non-specific student in Age group 2. While 1 convergence excess, and 0 non-specific student in Age group 1 as shown in Figure 2.

Table 1 & 2 show the data of negative fusional divergence break-up and recovery point at distance with mean value of 10.06±4.8 Δ and 7.3± 4.7 Δ, respectively. Whilst negative fusional divergence break-up and recovery point at near with mean value of 11.67±4.7 Δ and 8.9± 4.42 Δ, respectively.

Table 1 Mean negative fusional amplitudes at distance and near

Fusional amplitudes	No of subjects	Mean	Standard deviation
Negative Fusional Divergence Distance Break Point	120	10.06	±4.86
Negative Fusional Divergence distance Recovery Point	120	7.38	±4.72
Negative fusional divergence near break point	120	11.67	±4.78
Negative fusional divergence near recovery point	120	8.98	±4.42

Table 2 Mean positive fusional amplitudes at distance and near

Fusional amplitudes	No of subjects	Mean	Standard deviation
Positive Fusional Convergence Distance Break Point	120	10.95	±6.11
Positive Fusional Convergence Distance Recovery Point	120	8.13	±5.57
Positive Fusional Convergence Near Break Point	120	12.05	±6.73
Positive Fusional Convergence Near Recovery Point	120	9.00	±5.92

Positive fusional convergence break-up and recovery point at distance with mean value of 10.95±6.11 Δ and 8.1± 5.57 Δ, respectively. Whilst positive fusional convergence break-up and recovery point at near with mean value of 12.05±6.7 Δ and 9± 5.92 Δ, respectively.

Mean value of negative fusional divergence break point and recovery point at distance for age group (18-21 years): 67 students is 9.42 Δ and 6.71 Δ, respectively whilst break point and recovery point at near is 11.34 Δ and 8.78 Δ, respectively. Mean value of negative fusional divergence break point and recovery point at distance for age group 2 (22-24 years); 48 students is 11.37Δ and 8.66 Δ, respectively while break point and recovery point at near is 12.33 Δ and 9.45 Δ, respectively. Mean value of negative fusional divergence break point and recovery point at distance for age group 3 (25-27years); 5 students is 6.4 Δ and 4.2 Δ, respectively whilst break point and recovery point at near is 9. Δ 6 and 6.8 Δ, respectively as shown in Table 3.

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Table 3 Mean negative fusional vergences at near and distance according to age groups

Break and recovery points	Age groups	Total no of subjects	Mean	P-values
*NFDD(BP)	18-21	67	9.4242	
	22-24	48	11.375	
	25-27	5	6.4	0.021
	Total	120	10.0667	
*NFDD (RP)	18-21	67	6.7121	
	22-24	48	8.6667	
	25-27	5	4.2	0.026
	Total	120	7.3833	
*NFDN (BP)	18-21	67	11.3485	
	22-24	48	12.3333	
	25-27	5	9.6	0.346
	Total	120	11.675	
*NFDN (RP)	18-21	67	8.7879	
	22-24	48	9.4583	
	25-27	5	6.8	0.395

*Negative Fusional vergence Divergence Distance Break Point, Negative Fusional vergence Divergence Distance recovery Point, Negative Fusional vergence Divergence near Break Point, Negative Fusional vergence Divergence near Recovery Point

Mean value of positive fusional convergence break point and recovery point at distance for age group 1(18-21 years); 67 students is 10.55 Δ and 7.79 Δ, respectively while break point and recovery point at near is 11.47 Δ and 8.35 Δ, respectively. Mean value of positive fusional convergence break point and recovery point at distance for age group 2 (22-24 years); 48 students is 11.75 Δ and 8.85 Δ, respectively while break point and recovery point at near is 12.95 Δ and 9.95 Δ , respectively. Mean value of positive fusional convergence break point and recovery point at distance for age group 3 (25-27 years); 5 students is 8.8 Δ and 5.8 Δ ,respectively while break point and recovery point at near is 11.2 Δ and 8.4 Δ, respectively as shown in Table 4.

Table 4 Mean positive fusional vergences at near and distance according to age groups

Break and recovery points	Age groups	Total no of subjects	Mean	P-values
¥PFCD(BP)	18-21	67	10.55	
	22-24	48	11.75	
	25-27	5	8.8	
	Total	120	10.95	0.42
¥PFCD(RP)	18-21	67	7.79	
	22-24	48	8.85	
	25-27	5	5.8	
	Total	120	8.13	0.38
¥PFCN(BP)	18-21	67	11.47	
	22-24	48	12.95	
	25-27	5	11.2	
	Total	120	12.05	0.49
¥PFCN(RP)	18-21	67	8.35	
	22-24	48	9.95	
	25-27	5	8.4	
	Total	120	9	0.35

¥Positive Fusional Convergence Distance Break Point, Positive Fusional Convergence Distance recovery Point, Positive Fusional Convergence Near Break Point, Positive Fusional Convergence Near Recovery Point

In males mean value of negative fusional divergence break point and recovery point at distance is 9 86 Δ and 7.27 Δ respectively while in females this is 10.18 Δ and 7.44 Δ, respectively. In males mean value of negative fusional divergence break point and recovery point at near is 11.39 Δ and 8.67 Δ, respectively while in female's break point and recovery point at near is 11.83 Δ and 9.15 Δ respectively as shown in Table 5.

Table 5 Mean negative fusional divergence Gender-wise

Break and recovery points	Gender	Total no of subjects	Mean	P-values
*NFDD Break Point	Male	43	9.86	
	Female	77	10.18	0.73
	Male	43	7.27	
*NFDD Recovery Point	Female	77	7.44	0.858
*NFDN Break Point	Male	43	11.39	
	Female	77	11.83	0.635
*NFDN Recovery Point	Male	43	8.67	
	Female	77	9.15	0.57

*Negative Fusional vergence Divergence Distance Break Point, Negative Fusional vergence Divergence Distance recovery Point, Negative Fusional vergence Divergence near Break Point, Negative Fusional vergence Divergence near Recovery Point

In males mean value of positive fusional convergence break point and recovery point at distance 11.34 Δ and 8.51 Δ, respectively while break point and recovery point in females is 10.74 Δ and 7.92 Δ, respectively. Mean value of positive fusional convergence break point and recovery point at near in males is 12.16 Δ and 8.79 Δ, respectively while in females these are 12.0 Δ and 9.1 Δ, respectively as shown in Table 6.

Table 6 Mean positive fusional divergence Gender-wise

Break and recovery points	Gender	Total no of subjects	Mean	P-values
¥ PFCD Break Point	Male	43	11.34	
	Female	77	10.74	0.6
¥ PFDD Recovery Point	Male	43	8.51	
	Female	77	7.92	0.58
¥ PFCN Break Point	Male	43	12.16	
	Female	77	12	0.9
¥ PFCN	Male	43	8.79	
Recovery Point	Female	77	9.11	0.77

¥Positive Fusional Convergence Distance Break Point, Positive Fusional Convergence Distance recovery Point, Positive Fusional Convergence Near Break Point, Positive Fusional Convergence Near Recovery Point

One way ANOVA test was applied to see whether negative fusional amplitudes and positive fusional amplitudes depends on the age. A p-value <0.05 was considered significant. The result for negative divergence break and recovery point at distance were significant with p-value of 0.021 and 0.026 respectively while rest results were not significant age wise. To reveal whether FVA depends on gender, independent sample t-test was used but results were not significant.

Discussion

In this study fusional amplitudes were measured among Isra School of optometry students. Negative fusional divergence break-up and recovery point at distance and near was 10.06±4.8 Δ and 7.3± 4.7 Δ & 11.67±4.7 Δ and 8.9± 4.42 Δ, respectively. While Positive fusional convergence break-up and recovery point at distance and near was 10.95±6.11 Δ and 8.1± 5.57 Δ & 12.05±6.7 Δ and 9± 5.92 Δ, respectively.

Alrasheed SH. et al, conducted comparative cross-sectional hospital-based study in the binocular vision clinic at the Al-Neelain Eye Hospital from Feb to July 2020. They measured fusional vergence amplitudes (positive and negative) of 122 Sudanese patients (67 females and 55 males) with near Exophoria. Their mean age was 6.79 ± 5.22 years. They used Maddox wing to measure near Exophoria while FVA were calculated by two methods, prism bar and synoptophore. By using prism bar their results showed that the mean value of positive fusional vergence (PFV) and negative fusional vergence (NFV) were 22.6± (7.6) and 13.9± (3.9), respectively at near. While using synoptophore results showed that the mean value of positive fusional vergence (PFV) and negative fusional vergence (NFV) were 24.7± (7.2) and 12.7± (3.7), respectively at near.[15] Mvula, A. et al., carried out a cross-sectional qualitative study among Mzuzu University students from September 2021 to March 2022. A total of 99 healthy participants, comprising 62 males (62.6%) and 32 females (37.4%), were taken. Their mean age was 23.37 ± 3.95 years. They reported that the mean values for Negative Fusional Vergence (break-up and recovery points) were 19.27 ± (1.52) and 13.57 ± (1.26) respectively, at near, and Positive Fusional Vergence (break-up and recovery points) were 24.47 ± (2.80) and 14.68 ± (1.73), respectively at near.[16] However, in our study, the mean values for Negative Fusional Vergence at near (break-up point and recovery point) were 11.67 ± (4.7) and 8.98 ± (44.4), respectively. While Positive Fusional Vergence, (break-up point and recovery point) the values were 12.05 ± (6.7) and 9.00 ± (5.9) respectively, at near. Our fusional amplitudes are low as compared to their study and these changes might be due to different sampling technique, age groups and study methodology.

Palomo Álvarez, et al, conducted study on a sample consisting of 271 persons which included 104 women and 167 men. They grouped them into six groups according to age: 21-30 years; 31-40 years; 41-50years; 51-60 years; 61-70 years; 71-80 years. Heterophoria was measured by Von Grafe technique while Risley rotary prisms were used to calculate horizontal fusional vergence for different age groups at distance. For age group 21-30 years the values for NFV (break-up and recovery points) were 9.5± (2.8) and 5.2± (2.2), respectively whilst PFV (break, and recovery points) were 19.3± (8.2) and 8.2± (5.4), respectively.[17]

Sreenivasan V, et al., assessed heterophoria, accommodation, and fusional vergence range in infants, preschoolers and adults during fusional range assessment. They reported that mean fusional vergence range is similar for infants, preschool and adults with Base-In and Base Out prism.[18]

Etezad RM, et al, conducted study in Khatam Al Anbia Eye Hospital reported the values for NFV and PFV at distance. They reported break-up and recovery points were 7.78 ± (3.03) and 4.78 ± (2.40) respectively, for NFV and 10.88 ± (4.61) and 7.85 ± (4.40) respectively, for PFV.[19] On the other hand our study, the values for NFV (break-up and recovery points) were 10.04 ± (4.6) and 7.38 ± (4.72), respectively and for PFV (break-up and recovery points), the values were 10.95 ± (6.11) and 8.133 ± (5.57), respectively at distance. Whilst Costa Lança, C & Rowe FJ, reported reduced convergence break point in exophoric children as compared to esophoric and orthophoric subjects[20] and age appears to be a contributing factor in the variation shown in studies for vergence break points determined using the step vergence approach.[21]

FU T, et al., disclosed that convergence amplitudes of children with intermittent exotropia are lowered, as determined by the prism bar and synoptophore.[22] Nevertheless, Padavettan C, et al., revealed that reading text on a smartphone has a more noticeable effect on vergence characteristics.[23] One study has reported that vergence facility is dependent on age.[24]

Conclusion

This study concluded that the students of ISRA School of Optometry, University of ISRA, Karachi campus had reduced fusional vergence amplitudes (FVA) at near and distance while age and gender has no effects on distance and near FV except that their age may have significant effect on negative fusional break point and positive fusional recovery point.

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None

Conflicts of interest

None

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