ORIGINAL ARTICLE

Comparison of Changes in High Order Ocular Aberrations after Near Work in Myopic and Myopic Astigmatic University Students

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Abstract:

Objective: To compare changes in high order ocular aberrations (HOA) in myopic and myopic astigmatic university students after doing near work (reading continuously for 30 minutes).

Method: This Quasi experimental study was conducted after the approval of ethical review board of College of Ophthalmology and Allied Vision Sciences, (KEMU) Lahore. The study took place in COAVS/Mayo Hospital Lahore from March, 2024 to November, 2024. Sample size was 60 in which 22 were male and 38 were female students. Myopic university students ageing between 18 to 30 years were included. Data collection procedure consisted of pre and post reading measurement of HOAs with SIRIUS ORB scan. Data was entered and analysed using SPSS version 26. Paired t test was applied to check for statistical significance. P value ≤ 0.05 was considered significant.

Results: After near work for 30 minutes, myopes showed mean increase in spherical Abs i.e. 0.10 ± 0.03 to 0.12 ± 0.05 (P 0.001), Coma i.e.0.14 ± 0.06 to 0.16 ± 0.07 (p 0.021), astigmatic i.e. 0.45 ± 0.36 to 0.50 ± 0.38 (P 0.014). However, Compound myopic astigmatic patients showed mean decrease in spherical Abs i.e. 0.12 ± 0.05 to 0.09 ± 0.06 (P 0.037) and Coma abs i.e. 0.16 ± 0.14 to 0.15 ± 0.13 (P 0.026).

Conclusion: High order ocular aberrations after doing near work increased in myopes and decreased in those with myopic astigmatism. *Al-Shifa Journal of Ophthalmology 2026; 22(1): 33-41.*

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Originally Received: 15 Aug 2025
Revised: 23 Nov 2025
Accepted: 6 Feb 2026

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Introduction:

Ocular aberrations are the retinal image imperfections to unequal refraction and focus of light rays by refractive structure of eye on retina.[1] Ocular aberrations are of two types i.e. lower-order (0, 1, 2 order) and higher-order aberrations. Lower order aberrations include positive defocus, negative defocus, and regular astigmatism. Low order aberrations account for approximately 90% of the overall wave aberration in the eye[2]While Higher-order aberrations include Coma, Spherical aberration, Trefoil, and Quadrifoil. Higher-order aberrations (HOAs) cannot be corrected by simple sphere and cylinder corrections. HOAs may be cause of glare, halos and decrease contrast after corneal refractive surgery.[3] Common refractive errors in University Students are myopia, hyperopia, and astigmatism which cause blur vision. Investigation of myopia's prevalence and risk factors is essential for

early detection, intervention, and prevention of vision impairment.[4]

The highest prevalence of hyperopia in children and adults was seen in the America.[5]Refractive errors were significantly associated with positive family history and mobile use per day.[6]Prolonged near-work activities, such as reading, writing, and using digital devices, have been associated with various visual effects. Understanding effects of extensive near work on vision is necessary to reduce its bad effects on visual performance.[7] Near work also effects on ocular aberrations of the eye. A previous study enlightens that corneal wavefront aberrations coefficients change significantly after near work like reading.[8] Because of the lens's shape and position change during accommodation, optical aberrations also change. Since most modern activities necessitate ocular accommodation, which in turn causes changes in eye aberrations.[9] All near tasks require activation of ocular accommodation to see clearly which effectively leads to variation in eye aberrations.[10]Pupil controls the amount of light entering the eye, thus variation in pupil size influences the amount of light reaching retina ultimately affecting image quality and visual perception. Pupil size variation also effects ocular aberrations which increase in magnitude with increasing pupil size. In a study, Spherical abs were increased more when pupil size change 4 to 5 than 5 to 6mm.[11] The purpose of this study was to evaluate the impact of near work and pupil size on ocular high order aberrations in myopic and myopic astigmatic university students.

Methodology:

This Quasi experimental study was conducted after the approval of ethical review board of College of Ophthalmology and Allied Vision Sciences (COAVS), Lahore. The study took place in COAVS/Mayo hospital, Lahore. Students of COAVS and KEMU, Lahore participated in Research. Sample size was 60 and calculated by formula, $n = \frac{Z^2 P(1-P)}{d^2}$,by taking confidence level 95%, anticipated population proportion 0.04 and absolute precision required as 0.05.[12] Students of both gender and ageing 18-30 years diagnosed with myopia (-0.50D to -6.0D) or myopic astigmatism (-0.50D to -3.0D) were included. Exclusion criteria was age greater than 30 years, high refractive error more than -6.0D, emmetropia, hyperopia, ocular deviation and other any ocular pathology which hinders the measurement of aberrations. After informed consent each participant underwent a preliminary optometric examination including assessment of visual acuity and refractive error. The data collection consisted of two sessions: pre and post reading. For each subject, pre-reading higher order ocular wave front aberrations (Astigmatic, Coma, Trifoil, Spherical, and Quadrifoil) of both eyes were measured with SIRIUS ORB scan. After the measurement the subjects were seated comfortably and instructed to read book in an optimum lighted room for 30 min continuously. All subjects wore spectacle correction during the reading. Immediately after reading HOAs were again measured with same instrument and at the same time pupil size were also measured by orb scan. Data was entered and analysed using Statistical package for social sciences (SPSS version 26). Qualitative variables are presented as frequency and percentage. Quantitative variables are presented as means ± standard deviation. Paired t test was applied to check the level of significance. P value ≤ 0.05 was considered significant.

Results:

Statistically significant changes in high order aberrations after reading occurred in both eye combined myopes shows increase in spherical (p 0.001), Coma (p 0.021), Astigmatic (P 0.014) and Quadrifoil (P 0.021) (Table 2).

Table 1: Demographics

Gender (%)	
Male	Female
22 (18.3%)	38 (63.7%)
Pupil Size in millimeter (Mean±SD)	
Right Eye	Left Eye
3.94 ± 0.64	3.96 ± 0.57
Age in Years (Mean±SD)	
22.0 ± 1.97	

Compound myopic astigmatic students showed mean decrease in spherical (P 0.037) and Coma (P 0.026) (Table 2).

Table 2: Comparison of mean aberrations before and after near work across categories of refractive error

		Cylinder (n=)			Sphere (n=)			Sphere + Cylinder (n=)		
Sr	Parameter	Right Mean± SD	Left Mean± SD	P Value	Right Mean± SD	Left Mean± SD	P Value	Right Mean±SD	Left Mean±SD	P Value
1	Spherical	0.01 ± 0.04	-0.001 ± 0.02	0.253	0.02 ± 0.04	0.01 ± 0.03	0.276	0.02 ± 0.04	0.02 ± 0.05	0.968
2	Coma	0.01 ± 0.02	0.01 ± 0.04	0.772	0.01 ± 0.06	0.02 ± 0.06	0.525	0.03 ± 0.11	0.04 ± 0.11	0.091
3	Astigmatic	0.04 ± 0.15	0.05 ± 0.12	0.846	0.02 ± 0.13	0.06 ± 0.16	0.425	0.16 ± 0.34	0.08 ± 0.24	0.556
4	Trifoil	0.009 ± 0.03	-0.004 ± 0.08	0.641	0.31 ± 1.79	0.02 ± 0.14	0.344	0.01 ± 0.11	0.009 ± 0.07	0.806
5	Quadrifoil	0.008 ± 0.08	-0.005 ± 0.03	0.925	0.01 ± 0.06	0.01 ± 0.06	0.770	0.00 ± 0.07	0.03 ± 0.09	0.498

When both eyes were compared separately, right eye showed decrease in spherical (P 0.006) and Quadrifoil (P 0.021). However, left eye showed decrease in spherical (P 0.038) and increase in coma (P 0.048), (Table 3).

Table 3: Comparison of mean change in high-order optical aberrations in right eye versus left eye across different refractive error categories.

		Sphere + Cylinder (n= 25)			Sphere (n= 74)			Cylinder (n= 21)		
Sr No	Parameter	Before Mean ±SD	After Mean± SD	P Value	Before Mean± SD	After Mean± SD	P Value	Before Mean ±SD	After Mean ±SD	P Value
Both Eyes Combined										
1	Spherical	0.12 ± 0.05	0.09 ± 0.06	0.037*	0.10 ± 0.03	0.12 ± 0.05	0.001*	0.10 ± 0.06	0.11 ± 0.06	0.255
2	Coma	0.15 ± 0.14	0.16 ± 0.13	0.746	0.14 ± 0.06	0.16 ± 0.07	0.021*	0.15 ± 0.06	0.17 ± 0.06	0.120
3	Astigmatic	1.04 ± 0.62	1.15 ± 0.54	0.055	0.45 ± 0.36	0.50 ± 0.38	0.014*	0.75 ± 0.63	0.81 ± 0.62	0.102
4	Trifoil	0.11 ± 0.06	0.12 ± 0.06	0.468	0.11 ± 0.06	0.13 ± 0.10	0.110	0.13 ± 0.08	0.13 ± 0.12	0.904
5	Quadrifoil	0.09 ± 0.06	0.10 ± 0.08	0.435	0.06 ± 0.04	0.08 ± 0.06	0.021*	0.07 ± 0.07	0.06 ± 0.04	0.659
Right Eye										
6	Spherical	0.12 ± 0.07	0.10 ± 0.07	0.135	0.10 ± 0.03	0.12 ± 0.05	0.006*	0.09 ± 0.02	0.11 ± 0.05	0.157
7	Coma	0.20 ± 0.17	0.18 ± 0.15	0.425	0.15 ± 0.07	0.17 ± 0.07	0.213	0.15 ± 0.05	0.17 ± 0.07	0.184
8	Astigmatic	1.06 ± 0.67	1.19 ± 0.58	0.131	0.49 ± 0.42	0.52 ± 0.43	0.232	0.61 ± 0.58	0.66 ± 0.57	0.398
9	Trifoil	0.09 ± 0.06	0.11 ± 0.07	0.564	0.11 ± 0.05	0.13 ± 0.08	0.282	0.12 ± 0.07	0.13 ± 0.06	0.484
10	Quadrifoil	0.10 ± 0.08	0.10 ± 0.09	0.901	0.06 ± 0.04	0.07 ± 0.05	0.164	0.08 ± 0.10	0.07 ± 0.04	0.823
Left Eye										
11	Spherical	0.11 ± 0.02	0.08 ± 0.05	0.174	0.11 ± 0.03	0.12 ± 0.04	0.038*	0.12 ± 0.08	0.12 ± 0.07	0.818
12	Coma	0.10 ± 0.04	0.15 ± 0.11	0.202	0.13 ± 0.05	0.16 ± 0.07	0.048*	0.16 ± 0.06	0.17 ± 0.05	0.354
13	Astigmatic	1.02 ± 0.57	1.10 ± 0.52	0.275	0.42 ± 0.29	0.48 ± 0.32	0.030*	0.86 ± 0.67	0.92 ± 0.66	0.160
14	Trifoil	0.13 ± 0.06	0.14 ± 0.06	0.683	0.11 ± 0.07	0.14 ± 0.12	0.238	0.13 ± 0.09	0.13 ± 0.15	0.875
15	Quadrifoil	0.07 ± 0.03	0.10 ± 0.08	0.300	0.06 ± 0.04	0.08 ± 0.06	0.065	0.06 ± 0.03	0.05 ± 0.04	0.534

Table 4: Comparison of mean change between Sphero-cylinder, sphere and cylinder

Sr No		Sphero Cylinder	Spherical	Cylinder	P value
Both Eyes					
1	Spherical (Mean±SD)	-0.022 ± 0.05	0.016 ± 0.04	0.009 ± 0.03	<0.001*
2	Coma (Mean±SD)	0.007 ± 0.11	0.018 ± 0.06	0.013 ± 0.038	0.815
3	Astigmatic (Mean±SD)	0.11 ± 0.27	0.044 ± 0.152	0.052 ± 0.139	0.284
4	Trifoil (Mean±SD)	0.013 ± 0.08	0.0226 ± 1.26	0.001 ± 0.071	0.695
5	Quadrifoil (Mean±SD)	0.012 ± 0.078	0.016 ± 0.06	-0.006 ± 0.068	0.359
Right Eye					
6	Spherical (Mean±SD)	-0.02 ± 0.04	0.02 ± 0.04	0.02 ± 0.04	0.014*
7	Coma (Mean±SD)	-0.02 ± 0.10	0.01 ± 0.06	0.01 ± 0.03	0.261
8	Astigmatic (Mean±SD)	0.13 ± 0.31	0.02 ± 0.13	0.04 ± 0.16	0.229
9	Trifoil (Mean±SD)	0.01 ± 0.10	0.01 ± 0.09	0.01 ± 0.04	0.978
10	Quadrifoil (Mean±SD)	-0.002 ± 0.06	0.01 ± 0.06	-0.007 ± 0.10	0.581
Left Eye					
11	Spherical (Mean±SD)	-0.02 ± 0.05	0.01 ± 0.03	-0.001 ± 0.02	0.020*
12	Coma (Mean±SD)	0.04 ± 0.11	0.02 ± 0.06	0.01 ± 0.04	0.537
13	Astigmatic (Mean±SD)	0.08 ± 0.24	0.06 ± 0.16	0.05 ± 0.12	0.911
14	Trifoil (Mean±SD)	0.009 ± 0.07	0.02 ± 0.14	-0.004 ± 0.08	0.710
15	Quadrifoil (Mean±SD)	0.03 ± 0.09	0.01 ± 0.06	-0.005 ± 0.03	0.360

Table 5: Association of pupil size with mean change in Aberrations

Eye	Parameter	Pupil Size (Mean±SD)	Aberration mean change (Mean±SD)	Correlation Coefficient (r)	P value
Right	Spherical	3.94 ± 0.64	0.01 ± 0.048	-0.009	0.944
	Coma	3.94 ± 0.64	0.005 ± 0.073	0.046	0.729
	Astigmatic	3.94 ± 0.64	0.055 ± 0.196	0.125	0.342
	Trifoil	3.94 ± 0.64	0.160 ± 0.090	-0.022	0.867
	Quadrifoil	3.94 ± 0.64	0.007 ± 0.068	0.035	0.791
Left	Spherical	3.96 ± 0.57	0.002 ± 0.039	-0.057	0.666
	Coma	3.96 ± 0.57	0.024 ± 0.072	-0.032	0.808
	Astigmatic	3.96 ± 0.57	0.064 ± 0.173	0.081	0.538
	Trifoil	3.96 ± 0.57	0.018 ± 0.121	-0.159	0.225
	Quadrifoil	3.96 ± 0.57	0.016 ± 0.064	0.001	0.993

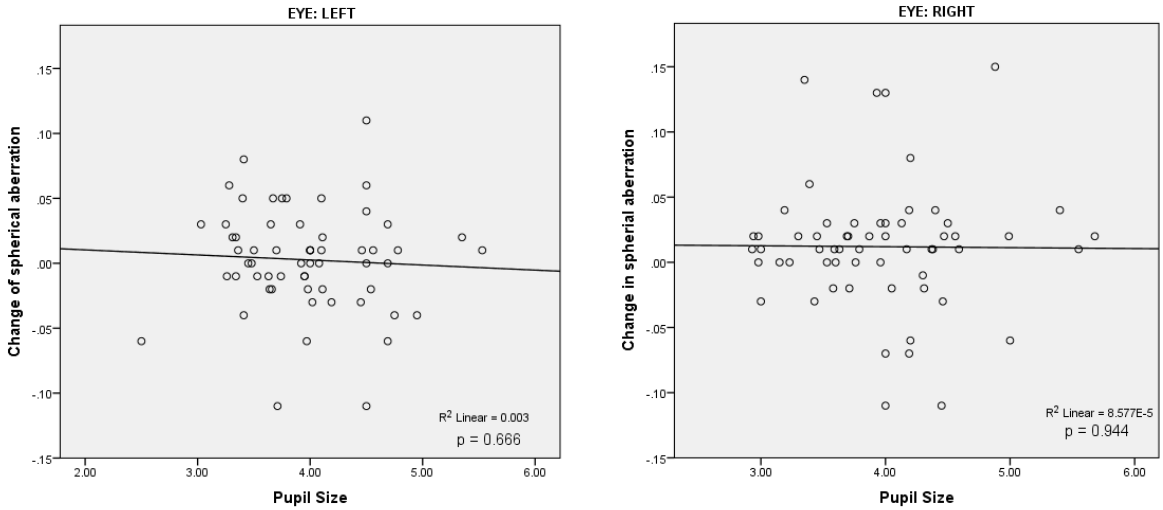

Figure 1. Graphical representation of Association of pupil size with mean change in spherical Aberration in both eyes (using Pearson correlation analysis)

Discussion:

This study compares the changes in HOAs after doing 30 minutes reading in myopes and myopic astigmatism. Myopes showed significant increase in HOAs such as in mean spherical 0.10 ± 0.03 to 0.12 ± 0.05(P 0.001), coma 0.14 ± 0.06 to 0.16 ± 0.07 (p 0.021), astigmatic0.45 ± 0.36 to 0.50 ± 0.38(P 0.014) and Quadrifoil 0.06 ± 0.04 to 0.08 ± 0.06 (p 0.021) while trefoil shows insignificant increase 0.11 ± 0.06 to 0.13 ± 0.10 (p 0.468). These changes were supported by Buehren T et al, 2024 in which the myopes have showed increased HOAs spherical 0.001 to 0.002, coma −0.018 to −0.016, astigmatic from 0.067 to 0.073, trifoil from 0.003 to 0.004 after reading of one and two hours and these changes nearly associated with smaller palpebral aperture during reading in the myopic persons.[13] Oberholzer M et al, 2019 agreed that myopes have increased negative spherical aberration changes ±0.007 µm per dioptre myopia during near tasks, causing a central hyperopic blur and a peripheral hyperopic defocus resulting in myopia progression.[14] Likewise, Ayyub F et al, 2022 showed myopes have more corneal RMS fourth 0.2803±0.16 (p 0.009), coma0.279±0.17 (p 0.03) and spherical 0.230±0.12 (p 0.008) and with increase of myopia also increase.[15] Gomes JRM et al, 2021 agreed that more changes in spherical–0.014 (p0.030), coma–0.010 (p0.039), Quadrifoil–0.006 (p0.029) and Trifoil–0.010 (p0.039) HOAs when reading on printed paper compare to computer screen.[10] Atchison DA et al, 2023 disagreed that with increase in accommodation changes mean decreased in spherical abs were -0.34 D (P <0.001) and third and other abs also changes with accommodation (p0.04).[16] Ghosh A et al, 2018 showed that near work have major role in myopia and HOAs changes from primary to down gaze as spherical –0.001 ±0.002 and 0.007 ± 0.004 with p 0.001, Quadrifoil 0.000 ± 0.005 and 0.016 ± 0.005 with p0.009, astigmatic 0.001 ± 0.005 and –0.016 ± 0.006 with p0.012 and coma 0.006± 0.00 and 0.022 ± 0.006 p0.031.[17] Karimian F et al, 2020 showed Compound Myopic Astigmatism have significant changes as mean decrease in spherical HOA 0.12 ± 0.05 to 0.09 ± 0.06 with p0.037* and coma abs 0.16 ± 0.14 to 0.15 ± 0.13 (P0.026*) while other HOAs and Simple Myopic Astigmatism have insignificant changes with p values of 0.055,0.468,0.435 and Changes between right and left when compared separately were varied such as right eye showed mean decreased in spherical 0.12 ± 0.05 to 0.09 ± 0.02 (p 0.006) and Quadrifoil 0.11 ± 0.05 to 0.07 ± 0.07 (P 0.021) while left eye decreased in spherical 0.11 ± 0.02 to 0.08 ± 0.05 (p 0.038) and increased in coma 0.13 ± 0.05 to 0.16 ± 0.11 (p0.048). A study agree our results that myopic astigmatic eyes have HOAs mostly with mean Primary horizontal trefoil

0.069±0.152μm, spherical−0.064±0.130μm primary vertical coma−0.038±0.148μm.[18] de Gracia P et al, 2022 nearly disagreed this study that astigmatism and HOAs have effects on visual performance. When coma 0.11 to 0.41μm and astigmatism range of 0.75 D was combined, a significant correlation was noticed and VA improved (p 0.027).[19] Leung T-w et al, 2022 parallels our results such as compared to myopia, myopic astigmatism have more negative trefoil with r=−0.69, p<0.001 and positive coma r=0.48, p=0.001 and these were strongly linked to asymmetry in corneal shape.[20] Jiménez R et al, 2018 agreed that near tasks with different difficulty level have significant effects on total RMS 7.45 (p 0.02), internal 4.33, (p 0.049), and astigmatic 4.89, (p 0.045), while Trifoil (p 0.059) ,spherical (p 0.316) and coma were insignificant effects.[21]This study showed that changes in HOAs in right vs left eye and different refractive error have insignificant p-values 0.770, 0.344, 0.425 and 0.525 except spherical HOAs with significant p<0.001. Carkeet A et al, 2020 agreed with our results that variations of HOAs in different refractive error groups i.e. myopia and astigmatism have significant changes in spherical HOA (p<0.001),while disagreed in astigmatic HOA (p 0.003) and defocus HOA (p 0.02) and all other types shows insignificant variations with p>0.05.[22]This study showed another results that insignificant changes in HOAs with pupil size variation between students right eye p-values range 0.342 to 0.944 and left eye p-value range 0.225 to 0.993. Castejón-Mochón JF et al, 2020 disagreed this study as aberrations rise in magnitude with increase in pupil size as in 3mm pupil have total RMS 0.5255μm ,5mm RMS 1.4901μm and 7mm RMS 2.9240 μm.[23] Another research showed that with increasing pupil size, ocular aberrations also increases specifically spherical HOA at 5 mm size increase in total RMS were 1.54, 1.59, 1.71, and 1.87.[11] Zhu X et al, 2020 showed that variation of pupil sizes from 4mm to 6mm have significant changes in aberrations like internal third-order (P0.009), coma (P0.001), total HOA (P 0.007) and ocular coma HOA (P 0.006).[24] McKelvie J et al, 2021 showed that high order ocular aberrations were significantly affected in subjects whose pupil size showed more variability of 54.6% in HOAs than lens tilt.[25] A small sample size comprising of certain age group and refractive error constitutes major limitation. Also variation in type of refractive error i.e. spherical, cylinder or combined also leaves the conclusion to have a limited clinical impact. Multicentre research with diverse sample will have to better understand the impact of pupil size with refractive error on ocular high order aberration.

Conclusion:

High order ocular aberrations after doing near work increase in myopes and decrease in myopic astigmatism. However, the change in type of high order ocular aberration may vary according to laterality.

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