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Original Article

Sighting Dominance, Biometric Parameters, and Refractive Status Analyzing the Role of Ocular Dominance

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Abstract

Objectives: The purpose was to study the association between ocular dominance, refractive status, and biometric parameters.

Methods: Ocular dominance was assessed on consenting participants with non-pathological eyes using "hole-in-the-card test." The participants were then examined for visual acuity, biometric measurements, and refraction. Data were analyzed using IBM SPSS software.

Results: Among a total of 660 participants in our study, right eye dominance was found in 508 (76.97%) participants. We found that horizontal keratometry readings (K1) were greater in the dominant eye compared to the non-dominant eye, showing a statistically significant difference in emmetropes ($p<0.001$) and hyperopes ($p<0.001$). The axial length was found to be longer but not significantly greater in dominant eye among while it was significant among myopes ($p<0.001$) and hyperopes ($p<0.001$). In myopic anisometropes, the axial length was significantly longer and more myopic in the dominant eye (24.0±0.7 mm) than non-dominant eye (23.9±0.4 mm) while the non-dominant eye was more hyperopic in anisometropic hyperopes.

Conclusion: Right eye was dominant in majority of participants. The dominant eye was more myopic and had greater axial length in anisometropes. The dominant eye was more astigmatic than the non-dominant eye. Visual acuity was not affected by ocular dominance. The mean difference in biometric measurements was significantly greater in hyperopic eyes. The assessment of ocular dominance could improve patient satisfaction in refractive surgeries and monovision treatments. Treatment protocols could be fine-tuned based on ocular dominance. Normative data in various biometric measurements could take into consideration laterality in terms of dominance.

Keywords: Axial length, keratometry, ocular biometry, refraction, refractive errors, sighting dominance

Introduction

"Among the major causes of visual impairment, uncorrected refractive errors accounted for about 43% of them worldwide (13). Twenty-first-century advances in refractive error management open various possibilities in the approach to refractive error correction with greater precision, particularly in refractive surgeries (14). The assessment of ocular dominance could be of advantage in the same. The dominant eye was found to be more myopic and with greater axial

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length than the fellow eye in several studies (15-17). In contrast, it was observed that the non-dominant eye was more myopic and more astigmatic compared to the fellow eye by Linke et al. (18) In hyperopes, it was noted that the non-dominant eye was more hyperopic and with greater astigmatic power with increasing anisometropia (19). This relationship with ocular sighting dominance can be imperative in clinical decisions involving refractive error management, cataract surgery, amblyopia management, and monovision treatments (20-22).

Most studies have been inconclusive and ocular dominance has not been studied with respect to biometric parameters and refractive errors in the Indian population. While studies have pointed to the benefits of assessing ocular dominance for clinical decisions, the results across dominance studies have been inconsistent. Hence, we intended to study the relationship between sighting dominance, biometric parameters, and refractive status in our population.

Methods

A cross-sectional study was conducted in consenting patients and volunteers meeting our inclusion criteria. Ocular sighting dominance was assessed using Dolman hole-in-the-card method by an examiner (23). Participants were asked to look through a three-centimeter diameter hole in a card with both eyes fixating on a distant object and each eye was closed alternately. If the image persisted on closing the eye, the open eye was considered dominant. If the image disappeared on closing one eye, the open eye was considered non-dominant. Three repetitive tests were conducted and confirmed if the three consecutive readings were identical. If either of the tests was non-identical or no preference was found, it was considered ambiguous and the participants were excluded from the study. The participants were then examined comprehensively for the anterior segment and posterior segment pathologies by a second examiner who was blinded to the dominance results, and if any of the above was found, the participants were excluded from the study. Subjects with glaucomatous optic nerve head changes, retinal pathologies, intraocular pressure more than 21 mmHg, anisometropia more than 2 Diopters, one-eyed individuals, post-ocular surgeries, ocular and adnexal trauma, amblyopia, cognitive disability, upper-limb deformities, squint and media opacities in either eye, unequal BCVA of two eyes, patients on contact lens were excluded from the study. Patients with poor visual acuity, i.e., unaided more than 1.0 log MAR value (Snellen equivalent 6/60) or BCVA more than 0.0 log MAR value (Snellen equivalent 6/6) in either eye were excluded from the study.

Visual acuity was assessed, refraction done using streak retinoscopy, and keratometry readings and axial length measured by the same examiner under the same conditions. Based on final refractive correction, they were classified as Group 1 (emmetropes), Group 2 (myopes), Group 3 (hypermetropes), and Group 4 (astigmatism). Anisometropes from Groups 2, 3, and 4 were again classified separately as Group A. All experimental protocols and procedures were approved by the Institutional Ethics Committee, KVG Medical College and Hospital (Approval no. KVGMCIEC202268 dated September 29, 2022) and complied with the tenets of the Declaration of Helsinki. The study was conducted after obtaining informed consent from each participant.

Statistical Analysis

Data were analyzed using IBM SPSS software version 27 (IBM Corp. Released 2020. IBM SPSS Statistics for Windows, version 27.0. Armonk, NY, USA: IBM Corp) (24). The compiled data were tested for normality by Shapiro–Wilk test. Statistical analysis was done using paired t-test and linear regression analysis. Kruskal–Wallis test with post hoc Dunn's test was done to assess the difference between the groups. The statistical significance was determined at $p<0.05$ in all analysis.

Results

Six hundred and seventy-three participants qualified for the study and were assessed, of which 660 showed eye dominance and the rest had ambiguous results or no eye preference. The mean age of participants was 33.24±11.32 years (8–65 years). Females accounted for 376 (56.96%) and males accounted for 284 (43.04%). Among the 660 participants, 508 (76.97%) demonstrated right eye dominance and 152 (23.03 %) had left eye dominance, indicating a predominant right eye dominance ($p<0.001$). We observed that 74 (26.05%) of males and 78 (20.74%) of females had left eye dominance. In our study population, there were 337 (51.06%) emmetropes whereas myopes, hypermetropes, and astigmatism constituted 118 (17.88%), 99 (15%), and 106 (16.06%), respectively.

We found that the horizontal keratometry readings (K1) were greater in the dominant eye; mean = 43.5±0.9 (41.5–46) compared to non-dominant eye; mean = 43.3±0.9 (41.75–46) There was a statistically significant difference in emmetropes (mean difference = 0.1695, $p<0.001$) and hyperopes (mean difference =0.46, $p<0.001$) but there was only a small difference in myopes ($p=0.199$), which was non-significant.

The vertical keratometry readings (K2) were greater in the dominant eye in all groups but significantly higher only among myopes (mean difference = 0.156, $p=0.007$) and hyperopes (mean difference = 0.846, $p<0.001$). The comparison of mean values of keratometry readings K1 and K2 between dominant and non-dominant eyes in all groups is described in Tables 1 and 2. The axial length was found to

Table 1. Comparison of mean values of horizontal keratometry readings K1 between dominant and non-dominant eyes in all groups

Mean values	Horizontal Keratometric Reading(K1)				
	Group 1 Mean±SD (range)	Group 2 Mean±SD (range)	Group 3 Mean±SD (range)	Group 4 Mean±SD (range)	Group A Mean±SD4 (range)
Dominant eye	43.5±0.9 (41.5–46)	43.5±0.4 (42.5–46)	43.1±0.5 (41.5–43.5)	43.6±0.7 (42.25–45.25)	43.5±0.8 (42–46)
Non-dominant eye	43.3±0.9 (41.75–44.5)	43.4±0.3 (42.5–45.5)	42.6±0.5 (41–43.25)	43.4±0.8 (42–45.5)	43.3±0.7 (42–45.5)
p	<0.001	0.199	<0.001	<0.001	0.476

Table 2. Comparison of mean values of horizontal keratometry readings K2 between dominant and non-dominant eyes in all groups

Mean values	Vertical keratometric reading (K2)				
	Group 1 Mean±SD (range)	Group 2 Mean±SD (range)	Group 3 Mean±SD (range)	Group 4 Mean±SD (range)	Group A Mean±SD4 (range)
Dominant eye	43.6±0.9 (41.75–46.25)	43.6±0.8 (42.5–45.5)	43.4±0.4 (42–44.25)	43.8±0.8 (42–46.25)	43.6±0.8 (42.5–46.25)
Non-dominant eye	43.5±0.8 (42–45.75)	43.5±0.5 (42.5–44.5)	43.2±0.3 (41.25–44.5)	43.6±0.7 (42.5–44.25)	43.6±0.5 (42.25–45.25)
p	0.057	0.007	<0.001	0.010	0.007

be longer but not significant in the dominant eye among emmetropes while it was significant among myopes (p<0.001) and hyperopes (p<0.001). The comparison of mean values of axial length between dominant and non-dominant eyes is shown in Table 3.

In myopic anisometropes, the axial length was significantly longer in the dominant eye (mean=24.0±0.7 mm) than non-dominant eye (mean =23.9±0.4 mm) while the non-dominant eye was more hyperopic in anisometropic hyperopes. Among participants with astigmatism, the dominant eye was more astigmatic than the non-dominant eye (p=0.011).

The difference in measurements between the dominant and non-dominant eyes was compared and plotted in a box and the whisker plot is shown in Figure 1 (K1), Figure 2 (K2), and Figure 3 (axial length).

The difference in measurements between dominant and non-dominant eyes in Groups 1, 2, and 3 was analyzed using the Kruskal–Wallis H test, and it showed a significant difference in the variable between the groups for horizontal keratometric reading K1 (p<0.001), vertical keratometric reading K2 (p=0.016), axial length (p=0.036), and anterior chamber depth (p=0.02). The post hoc Dunn's test using a Bonferroni correction of 0.017 showed significantly higher difference in keratometric readings between Groups 1 and 3 and Groups 2 and 3, implying a greater difference in Group 3 i.e. hyperopes. The difference in K1 and K2 measurements between the eyes was similar in emmetropes and myopes. The mean difference between the dominant and non-dominant eyes is plotted, as shown in Figure 4.

Table 3. Comparison of mean values of axial length between dominant and non-dominant eyes in all groups

Mean values	Axial length (mm)				
	Group 1 Mean±SD (range)	Group 2 Mean±SD (range)	Group 3 Mean±SD (range)	Group 4 Mean±SD (range)	Group A Mean±SD4 (range)
Dominant eye	23.3±0.8 (22.1–24.7)	24.0±0.7 (22.9–25.26)	22.8±0.7 (21.8–23.7)	24.0±0.5 (22.23–25.02)	24.0±0.7 (22.9–25.02)
Non-dominant eye	23.3±0.8 (22.03–24.6)	23.9±0.7 (22.5–26.6)	22.7±0.7 (21.7–23.62)	23.9±0.7 (21.18–25.14)	23.9±0.4 (22.25–25.14)
p	0.809	<0.001	<0.001	0.227	<0.001

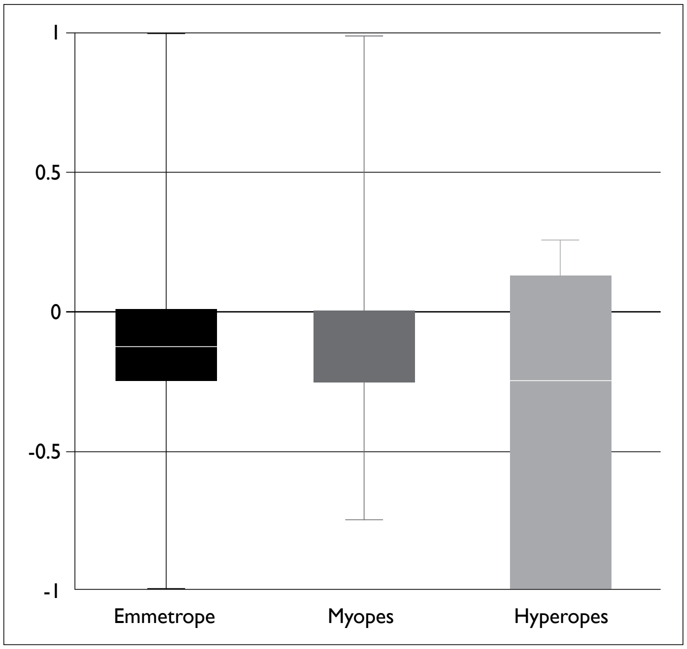

Figure 1. Difference in K1 reading between dominant and non-dominant eyes.

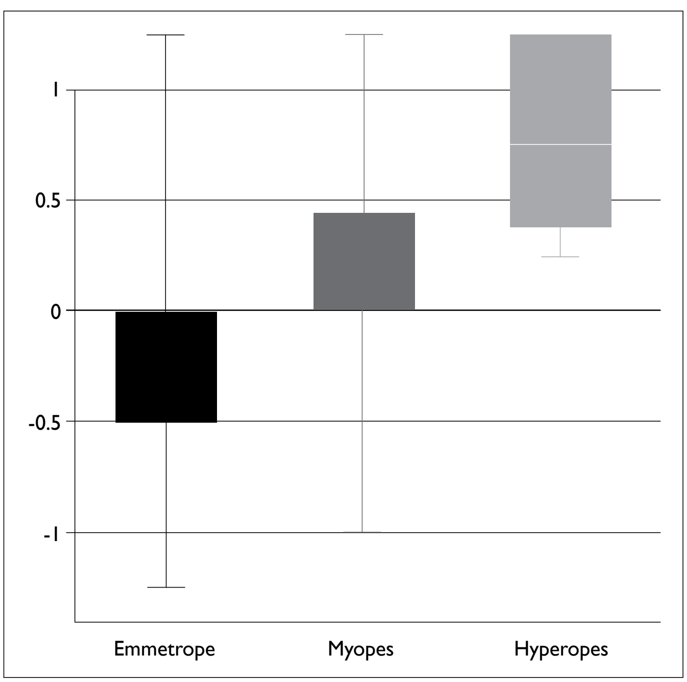

Figure 2. Difference in K2 reading between dominant and non-dominant eyes.

On linear regression analysis, there was no effect of age on the difference in axial lengths (R2=0.0004, p=0.776). Visual acuity was not associated with ocular dominance.

Discussion

We conducted a cross-sectional study to determine sighting ocular dominance and its relationship with biometric parame-

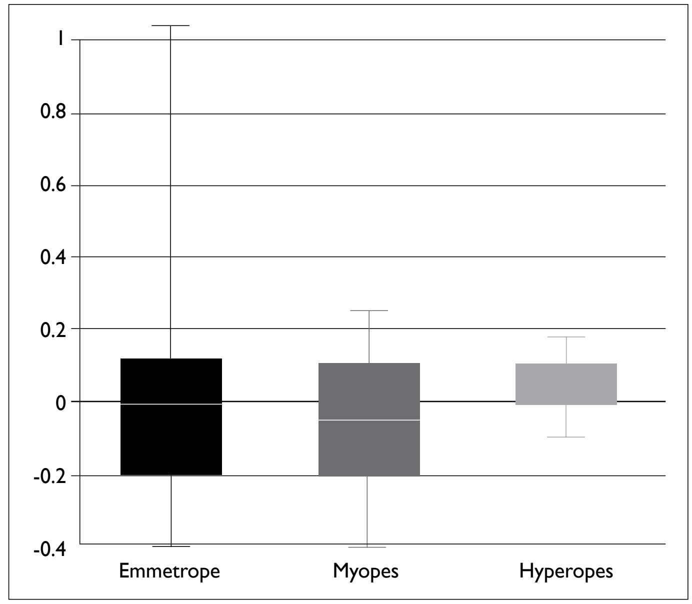

Figure 3. Difference in axial length between dominant and non-dominant eyes.

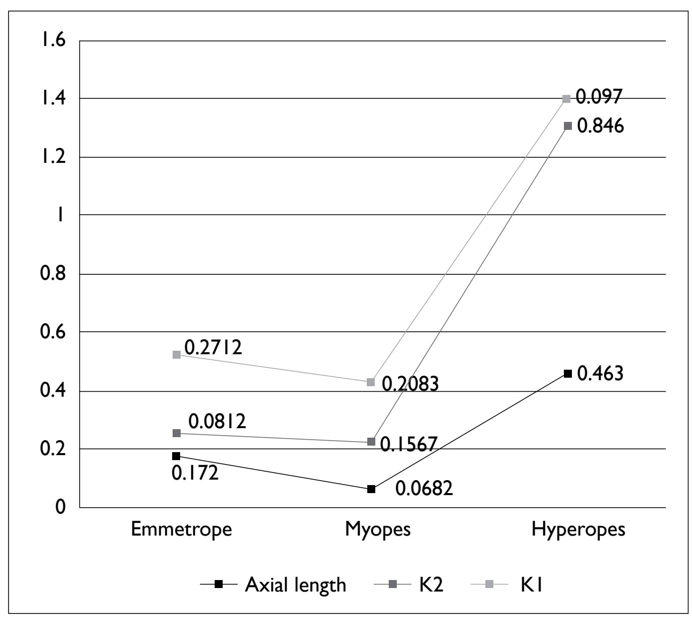

Figure 4. Mean difference in biometry readings between dominant and non-dominant eyes.

ters and refraction. Comparable to previous ocular dominance study, we also noted majority right eye dominance across all groups (25). Gender predilections to laterality of dominance were inconsistent with Eser et al.'s study, which showed lesser percentage of males having left dominance (15).

In anisometropes, the observations were similar to Samarawickrama et al.'s study on pediatric population aged 6–12 years wherein the dominant eye was longer and more myopic compared to the fellow eye (26). However, Linke et al. in their study on myopic candidates found the non-dominant eye to be more myopic and more astigmatic, while a contradicting study on hyperopes observed the non-dominant eye to be more hyperopic and more astigmatic (18,19). The visual acuity difference between the eyes was not affected by dominance in our population, congruent with observations by Dan Zhou et al. (27) Hence, considering the dominance while managing amblyopia and pathological myopia could prove useful. The effect of dominance on myopia progression with refractive correction needs to be studied prospectively as earlier observations have been inconclusive (26). Among anisometropic hyperopes in our study, we found the non-dominant eye to be more hyperopic than the dominant eye. It was consistent with findings from Linke et al.'s study, which however showed higher astigmatism in hyperopic eye (19).

With the increasing rates of refractive errors, especially myopia, the scope of understanding the development and progression of refractive errors has only become more significant (29). The recent theories of visual input-based development of the eye and refractive errors could be advantageous in the understanding of refractive error management (28). Difference in cerebral activation has also been observed between the dominant and non-dominant eyes (7,29,30). This, in turn, points toward a potential interaction with refractive errors and their progression with respect to dominance.

Ocular dominance is of special importance in monovision treatments, wherein the non-dominant eye is assumed to be easier to suppress blur (31,32). In monovision treatments by intraocular lens implantation to ocular dominance influenced patient satisfaction (32).

The role of ocular dominance in amblyopia management has been suggested. Coren observed that the non-dominant eyes tend to develop amblyopia in myopes (21). Consequently, the findings from our study could be of significance in the approach to refractive surgeries and amblyopia too.

The association of eye and hand dominance has been studied with several contrasting results. McManus et al. found that the writing hand and throwing hand related independently to the dominant eye, with a stronger correlation of the dominant eye to the throwing hand (33). Crossed hand-eye dominance have been implicated to be of importance in a variety of areas like sports such as tennis, golf, and archery (35-37). The association of hand-eye dominance has been studied in neuropsychiatric disorders too (38).

The implications of our observations are plenty and could open up further areas of research in understanding refractive errors with respect to ocular dominance. Newer functional imaging and other ocular dominance tests to ascertain and quantify dominance might be valuable in ophthalmic practice, particularly in preventing amblyopia (39). The selection of eye by dominance in refractive surgeries, particularly in anisometropes, could facilitate better patient satisfaction. The role of monovision technique also needs to be extensively studied. The use of dominance laterality in refraction and clinical approach is recommended.

Limitations of the Study

The limitations of our study include a small population size and a cross-sectional study. Large scale, multicentric prospective studies may be required to confirm and enhance our observations.

Conclusion

We analyzed the ocular sighting dominance and its association with biometric parameters and refractive status. Right eye was dominant in majority of the patients. Keratometry readings were higher in the dominant eye. The dominant eye was more myopic and had greater axial length in anisometropes. The dominant eye was more astigmatic than the non-dominant eye. The visual acuity was not affected by ocular dominance. The mean difference in biometric measurements was significantly greater in hyperopic eyes. The assessment of ocular dominance could improve patient satisfaction in refractive surgeries and monovision treatments. Treatment protocols could be fine-tuned based on ocular dominance with its possible quantification. Normative data in various biometric measurements could take into consideration laterality in terms of dominant and non-dominant eyes rather than right and left.

Disclosures

Ethics Committee Approval: All experimental protocols and procedures were approved by the Institutional Ethics Committee, KVG Medical College and Hospital (Approval no. KVGMCIEC202268 dated September 29, 2022) and complied with the tenets of the Declaration of Helsinki.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

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