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Correlation of Central Corneal Thickness and Corneal Curvature with Refractive Error in South Indian Population

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Abstract
Background: To identify the relation between central corneal thickness and corneal curvature with refractive errors. To find out whether there is any relation between central corneal thickness and corneal curvature with variables such as age and refractive error mainly myopia and hypermetropia. **Material and Methods:** This is an Observational cross- sectional study done on hospital based population. Data collected from patient with refractive error visiting our outpatient department. 70 subjects who met the inclusion criteria were included in the study. Following examination were performed for all the patients, measuring best corrected visual acuity, central corneal thickness, corneal curvature by topography, subjective refraction done using retinoscopy. All patients underwent a complete slit-lamp examination. Correlation identified using Karl Pearson's and spearman correlation coefficient. Data analysis done with SPSS 20.0 software. **Results:** The mean central corneal thickness of our population is 536.9 microns. The mean age of our study population was 41.7 years. The mean corneal curvature is 44.82 D. Astigmatism and Hypermetropia has significant correlation with central corneal thickness and corneal curvature. **Conclusion:** CCT has got a negative correlation with age that is as age progress CCT decreases. Astigmatism has a negative correlation with central corneal thickness and corneal curvature. Hypermetropia has a positive correlation between CCT and corneal curvature. There is also no significant association between central corneal thickness and corneal curvature in our study.
Keywords: CCT (Central Corneal Thickness), Corneal Curvature, Refractive Error.

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INTRODUCTION

Central corneal thickness is an important parameter in analyzing the general corneal status. Measurements of central corneal thickness (CCT) have become a major part of the clinical evaluation of patients. Over the years, the field of pachymetry has developed with the introduction of new and more advanced pachymeters. With the recent interest in refractive surgery and thus the need for CCT is rising. In glaucoma, CCT has a direct impact in intraocular pressure measurement.[1-2] Various refractive surgeries have developed and corneal thickness plays an important role in deciding the type of refractive surgery. Components that determine the overall refractive status of the eye include corneal power (mean 43 D) , anterior chamber depth (mean 3.4mm) , axial length (24mm) and power of the lens (mean 21 D).[3] There is still no clarity about the involvement of anterior segment in refractive errors. However considering an emmetropic eye to sphere and myopic eye being longer than emmetropic eye to prolate spheroid. According to the simple stretch theory, cornea should be thinner in myopes compared to emmetropes.[4]

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Studies correlating the relationship between refractive errors and CCT have revealed contradicting results. While few studies have found a correlation between CCT and myopia.[5,6,7] Some have reported no significant correlation.[8,9] This can be related to variations of the population studied as well as various methods of the measurement of corneal thickness. Given the increasing prevalence of refractive error in India, we attempted to study the relationship between refractive error and CCT and corneal curvature among patients attending the clinic of a tertiary care institute.

METHODOLOGY

Observational analytic cross-sectional study of data collected from patients with refractive errors presenting to the outpatient department of our hospital. Patients that met the inclusion criteria of age between 12- 72 years, both genders and refractive error of myopia, hyperopia and astigmatism were included in the study. Patients with corneal pathology like corneal oedema, opacities, dystrophies, keratoconus, any lenticular pathology like cataract, lenticonus, contact lens use within I month, any external eye disease like pterygium, history of trauma, retinal pathology like retinal detachment, retinitis pigmentosa were excluded from the study.
Patients from the out-patient clinic that met the inclusion criteria was recruited into the study from April till July 2023 till the required number of participants were obtained. Old and newly diagnosed patients with only refractive error were recruited into the study. Sample size of 70 eyes were obtained. Informed consent was obtained from each patient prior to the study. Ocular history was taken and ocular examination was carried out on each patient by the principal researcher and the ophthalmology resident doctor.
Ophthalmic assessment included visual acuity test using Snellen's chart, slit lamp examination, IOP measurement, dilated fundoscopy, cycloplegic refraction, pachymetry, keratometry. IOP was measured using non-contact tonometer. Patients' eyes were dilated with 1% cyclopentolate eye drops and a cycloplegic refraction was carried out using an auto-refractory keratometer. Central corneal thickness was measured using ultrasound pachymeter (PacScan300P Sonomed), corneal curvature obtained using automated keratometer (Topcon AR). Detailed anterior segment using slit-lamp biomicroscopy and fundus examination using slit-lamp biomicroscopy with 90D lens were done.
The refractive error was divived into five categories- low myopia (0 to -3D), Moderate (-3 to -6D), High Myopia(>-6D), Hypermetropia (>+0) and Astigmatism.
Data entry is done in Excel. We did data analysis with the help of SPSS 20.0 statistical software. Correlation between central corneal thickness (CCT) and factors including age , sex ,degree of myopia, hypermetropia, astigmatism and corneal curvature was studied using Karl Pearson's correlation coefficient(r) and spearman correlation coefficient(rho), represented on a Scatter plot diagram.

RESULTS

A total of 70 subjects were enrolled in the study. The total number of males were 33 (47.1%) and females were 37 (52.9%). The mean age was 41.7 years (range 12-72 years). In our study highest frequency of study participants belonged to the age of 20 years (11.4 %). Highest frequency in refractive error in our study was of Hypermetropia (30% of total subjects). Frequency of refractive errors in our study is shown in [Table 1].
In the low myopia group (0 to -3), the mean age is 36.31, SD 17.48 and the range is 12-66 years. In moderate myopia (-3 to -6), the mean age is 44.0, SD 21.16 and the range is 20-60 years. In high myopia, the mean age is 35.09, SD 16.75 and the range is 15-55 years.in hypermetropia the mean age is 54.71, SD 8.96 and the range is 43 to 71 years. In astigmatism the mean age is 35.31, SD is 13.18 and the range is 20 to 61 years [Table 2].

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The mean central corneal thickness in low myopia is 521.62 microns, SD 50.71 and range is 417.50 to 616.25 microns. In moderate myopia the mean CCT is 561.78 microns, the SD IS 67.65 and the range is 504.10 to 636.25. In high myopia the mean CCT is 562.88 microns, SD 55.91 and the range is 433.75 to 640 microns. In hypermetropia the mean CCT is 529.23, SD is 39.81 and the range is 402 to 577 microns. In astigmatism the mean CCT is 542.85 microns, SD is 38.55 and the range is 467 to 606 microns [Table 3].

The corneal curvature was measured in both vertical(k1) and horizontal(k2) meridian in dioptres. In the vertical(k1) meridian for low myopia the SD 1.807, Mean is 44.586, range is from 40.85 to 48.80 dioptres. In Moderate myopia the mean is 43.88, SD is 3.127, the range is from 40.40 to 46.45 dioptres. For high myopia the mean is 44.09, SD is 2.213, the range is from 40.40 to 47.50 dioptres. For hypermetropia the mean is 44.65, SD is 1.298, the range extends from 41.90 to 46.75. For Astigmatism the mean is from 44.47, SD is 1.477, the range is from 41.10 to 46.65 dioptres [Table 4].

Now in the horizontal (k2) meridians for low Myopia the mean is 45.27, SD is 1.807 and the range is from 42.35 to 49.40 dioptres. For moderate Myopia the mean is 44.36, SD is 2.73 & the range is from 40.90 to 47.85 dioptres. For high myopia the mean is 44.36, SD is 2.15 and the range is from 40.90 to 47.85 dioptres. For hypermetropia the mean is 44.86, SD is 1.419 & range is from 42.10 to 47.65 dioptres. For astigmatism the mean is 44.66, SD is 1.114 & the range is from 42.80 to 45.85 dioptres [Table 5].

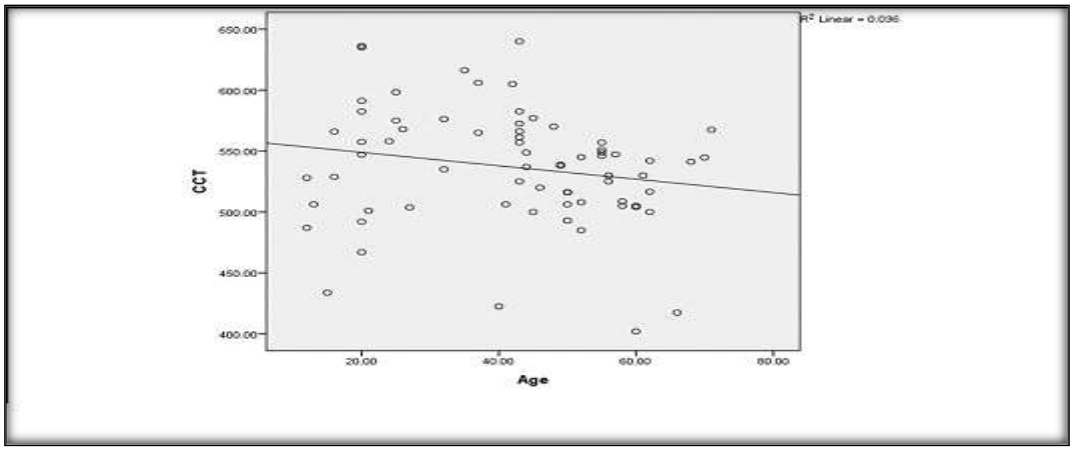

Figure 1: Showing negative correlation between Central corneal thickness and age

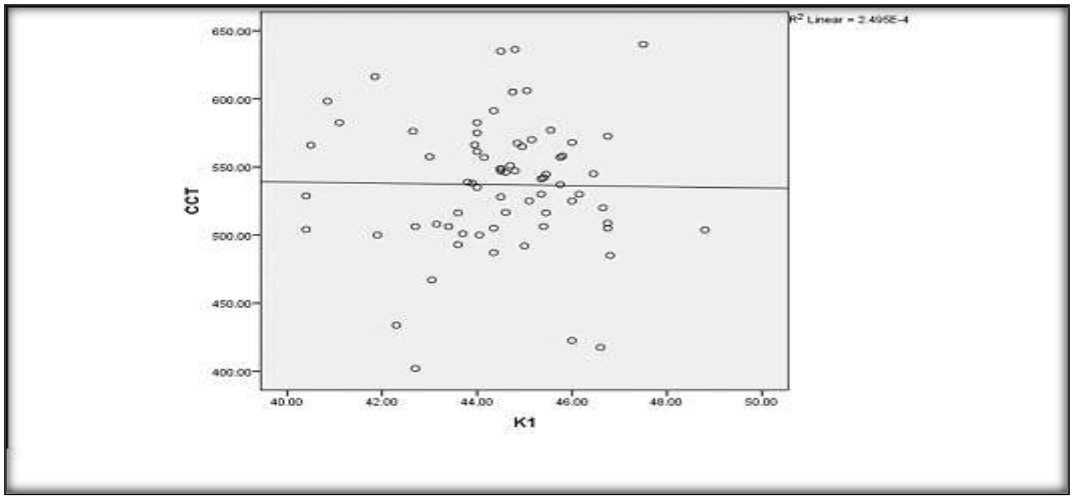

Figure 2: Showing no correlation between CCT and corneal curvature

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In astigmatism, corneal curvature and central corneal thickness has a negative correlation. P value being statistically significant of 0.615 and 0.405 respectively. This implies as astigmatism increases central corneal thickness and corneal curvature decreases. Figure 3 and 4.

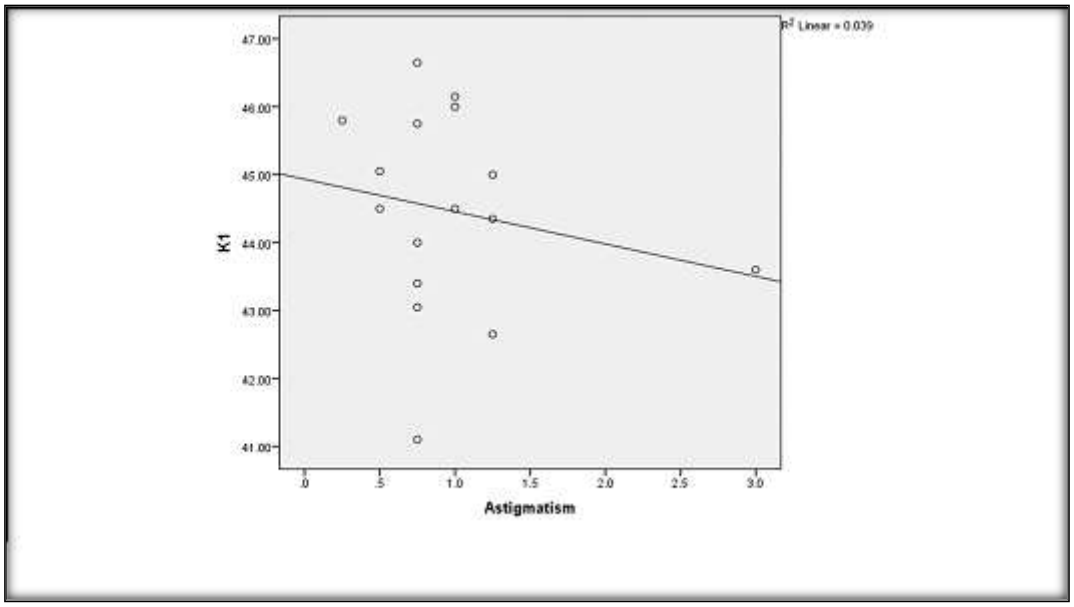

Figure 3: Showing negative correlation between Astigmatism and K 1

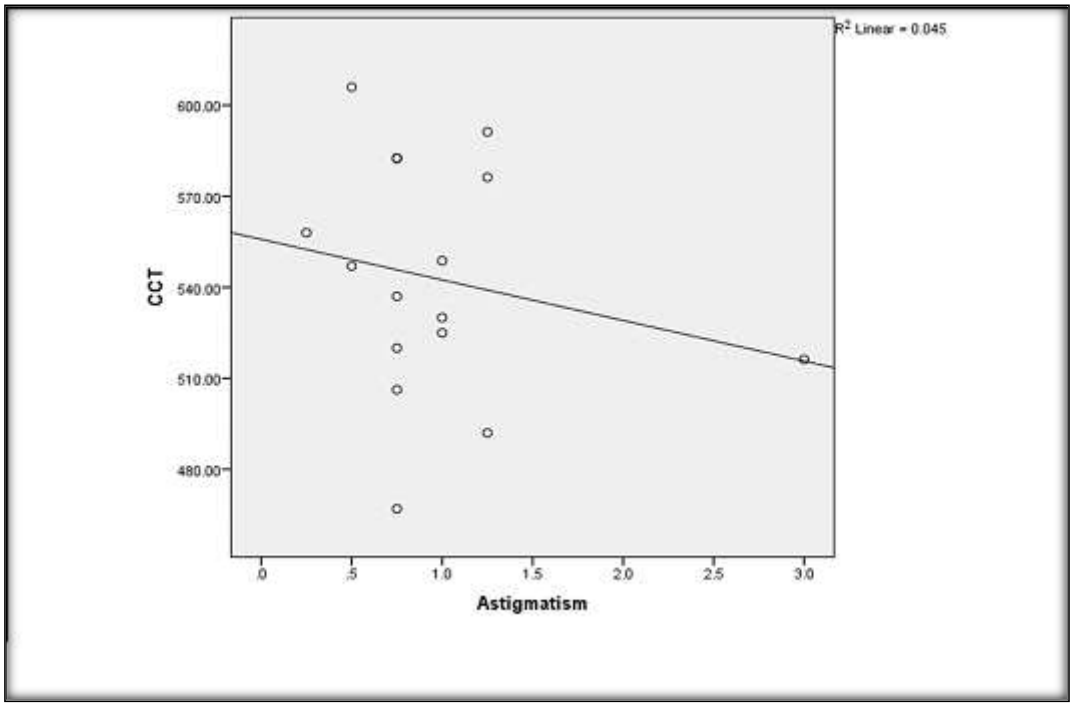

Figure 4: Showing negative correlation between CCT and Astigmatism

Myopia has minimal positive or no correlation with central corneal thickness and no correlation with corneal curvature in our study. Shown in scatter plot figure 5 and 6. A Straight line parallel to x axis in scatter plot depicts no correlation between the comparing factors.

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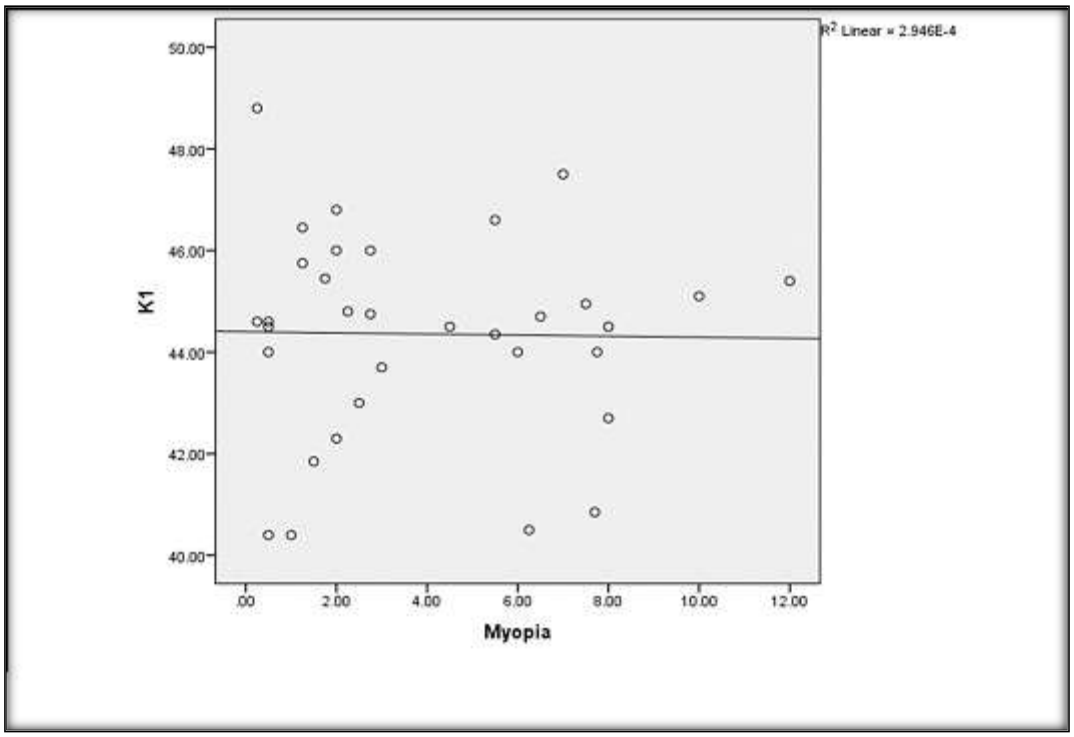

Figure 5: Showing no correlation between Myopia and corneal curvature

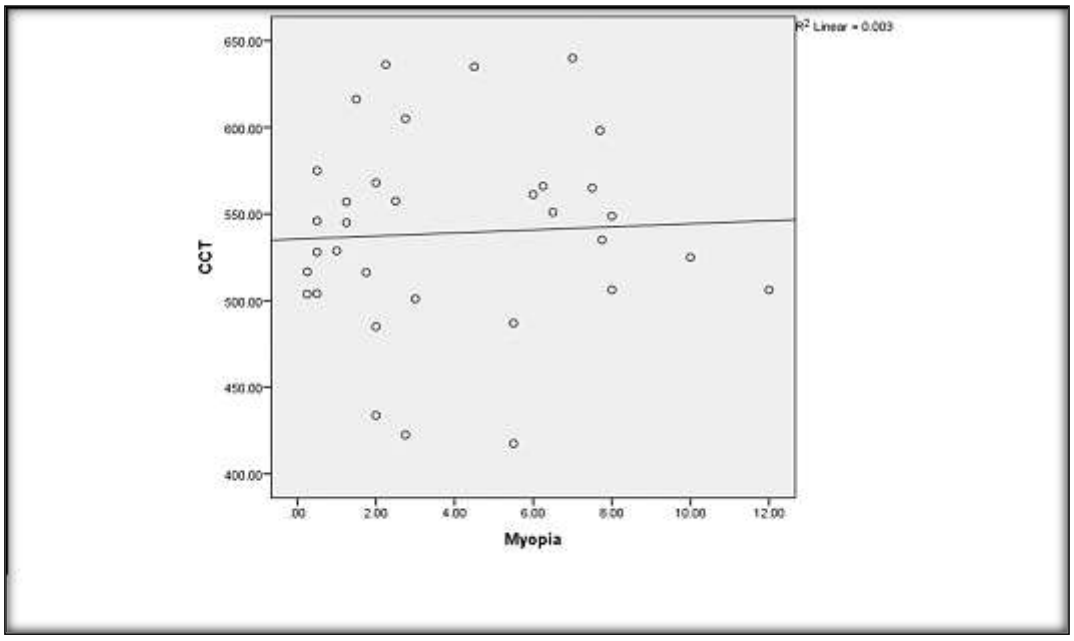

Figure 6: Correlation between CCT and Myopia

In our study hypermetropia has a positive correlation with central corneal thickness and corneal curvature with a p value of 0.806 and 0.05 respectively. Figure 7 and 8.This implies as hypermetropia increases CCT and corneal curvature increases.

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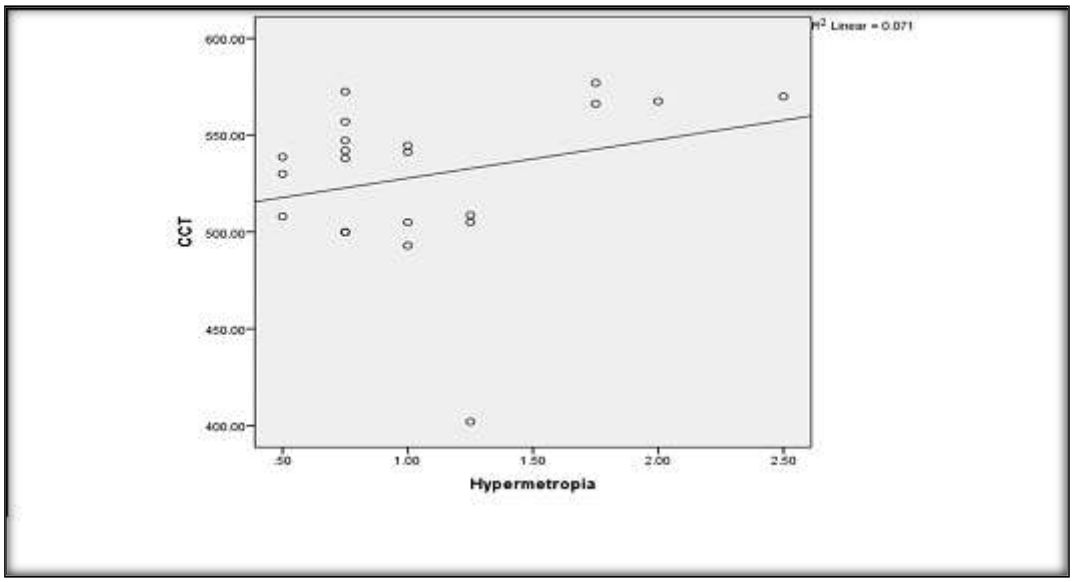

Figure 7: Showing positive correlation between CCT and hypermetropia

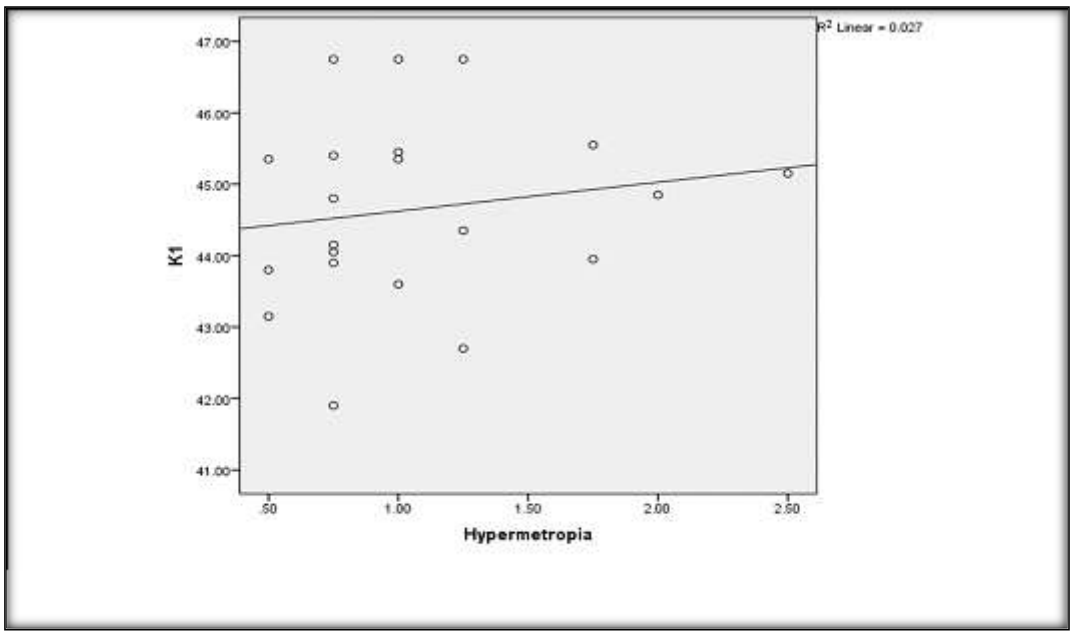

Figure 8: Showing positive correlation between hypermetropia and corneal curvature.

Table 1: Frequency of refractive error in study population

Refractive error	Frequency	Percent
Astigmatism	16	22.9
Hypermetropia	21	30.0
High Myopia	11	15.7
Low Myopia	19	27.1
Moderate Myopia	3	4.3
Total	70	100.0

Table 2: statistics of age in years by refractive errors

Refractive error	Mean	SD	Range
Low myopia	36.31	17.48	12-66
Moderate myopia	44.00	21.16	20-60

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High myopia	35.09	16.75	15-55
Hypermetropia	54.71	8.96	43 -71
Astigmatism	35.31	13.18	20-61

Table 3: statistics of CCT in microns by refractive errors

Refractive error	Mean CCT	SD	Range
Low myopia	521.62	50.71	417 – 616.25
Moderate myopia	561.78	67.65	504.10 -636.25
High myopia	562.88	55.91	433.75- 640
Hypermetropia	529.23	39.81	402- 577
Astigmatism	542.85	38.55	467 - 606

Table 4: statistics of K1 in dioptres by age

Refractive error	Mean K1	SD	Range
Low myopia	44.58	1.8	40.85 to 48.80
Moderate Myopia	43.88	3.12	40.40 to 47.50
High Myopia	44.65	1.29	41.10 to 46.75
Hypermetropia	44.65	1.29	41.90 to 46.75
Astigmatism	44.47	1.47	41.10 to 46.65

DISCUSSION

The Singapore Malay eye study a population based study of 3280 patients showed that refractive error formed a major part of ophthalmic disability [10] . The quality of life was reported to be compromised for moderate to high myopes.

Our study has attempted to find the correlation between central corneal thickness and corneal curvature with each other as well as with refractive errors and age.

CCT is an indicator of corneal status and supposedly has influence on both refractive errors especially axial length related refractive error and intraocular pressure of eye. In our study central corneal thickness had negative correlation with age similar to Lenskul., et al,[11] Foster., et al,[12] and Cho and Lam., et al.[13] Hahn et al. concluded that the decline in keratocyte density with age is responsible for the drop in CCT values.[14]

The relationship between the CCT and refractive errors is controversial. Li Jinghai reported there is a negative correlation between CCT and refractive errors.[15] Chang concluded there is no correlation between CCT and the type of refractive errors,[16] However, Zhang Shisheng reported there is a positive correlation between CCT and refractive error.[17]

Our study found a negative correlation between CCT and astigmatism. However not many studies have correlated CCT and astigmatism to the best of our knowledge. Hence their correlation is controversial and we recommend further investigations in this matter. Hashmani et al concluded in their study that astigmatism had a significantly positive correlation with CCT.[18] Mahmoud et al concluded no correlation between CCT and hypermetropia,[19] however we found a positive correlation with the same.

Chen et al concluded in their study a statistically significant correlation between corneal curvature and refractive errors.[20] However Mainstone et al and Grosvenor and Gos et al concluded no significant correlation between corneal curvature and refractive error.[21.22] Our study showed a negative correlation with astigmatism similar to Muhammed et al.[23]

Limitations of Study

Our study is limited by the clinical setting, small study group, short duration, same ethnicity and hence cannot be generalised. But all calculations and measurements were performed USG pachymetery, Topcon AR by the same surgeon and optometrist. Diurnal variation, genetic & racial differences in CCT were also not considered in our study.

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CONCLUSION

We conclude central corneal thickness has got a negative correlation with age in our study which implies as age increases CCT decreases. Astigmatism has a negative correlation with central corneal thickness and corneal curvature, that is as degree of Astigmatism increases, central corneal thickness and corneal curvature decreases and vice versa. However there is weak or no significant association between central corneal thickness and corneal curvature with other parameters like sex, degree of myopia. Hypermetropia has a positive weak correlation between CCT and corneal curvature. There is also no significant association between central corneal thickness and corneal curvature.

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