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# A CORRELATION STUDY OF AXIAL LENGTH AND CORNEAL CURVATURE TO CATEGORIZE REFRACTIVE STATUS.

**KEY WORDS:** Axial length, Cornea, Hyperopia, Myopia, Refractive errors,

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ABSTRACT

**Background:** Refractive errors have become the most common problem among humans and are the most common cause of blindness all over the world. Various treatment options are available to treat the patient with refractive errors; however, it is important to investigate the various factors which are affecting refractive errors. This study was conducted with the aim, to determine correlation of axial length and corneal curvature to categorize the refractive status. **Materials and methods:** After obtaining the institutional ethical clearance, a total of 150 patients, of either gender, aged between 20-50 years were examined on an outpatient departmental basis. So, a total of 300 eyes were examined over a period of 6 months. General and local examination, refractive error and measurement of axial length were done. The data obtained from this study was analyzed statistically. **Results:** Out of 150 patients 83 (55.3%) were females and 67 (44.7%) were males and mean age group of participants was 30.38 ± 8.239 (mean ± SD) years. 41(27.3%) were emmetropia, 19 (12.7%) hypermetropia, 90 (60.0%) myopia were the refractive errors for right and left eye respectively. Except for Right eye keratometry K2 43.74 ± 1.632 (Mean ± SD) was not significant (p = 0.310) and Left eye keratometry K2 43.67 ± 1.801 (Mean ± SD) was not significant (p = 0.218) the association of keratometry, axial length and power of right and left eye were significant. **Conclusion:** Myopic have higher axial length in comparison to emmetropia patients while hypermetropia patients had lower axial length of both the eyes. For both eyes, the flat meridian of the anterior corneal surface (K1) was found lesser in hypermetropia in comparison to emmetropia and myopia. Right eye axial length has negative correlation with right and left eye power and vice versa. Right eye K1 and right eye K2 is having negative correlation with right and left eye power. Left eye K1 is having positive correlation with right and left eye power while not with K2.

## INTRODUCTION:

The refractive state of the eye is determined by refractive components such as corneal power, lens power, anterior chamber depth, and axial length. [1] The axial length (AL) is distance from corneal surface to an interference peak corresponding to the retinal pigment epithelium, expressed in millimeters. [2] The changes in axial length appear to outweigh the progressive corneal flattening with age in normal eyes. [3] The cornea is a powerful refracting surface of the optical system of the eye, accounting for two-thirds of eye's focusing power. [4] Production of a sharp image at the retina requires corneal transparency and appropriate refractive power. The refractive power of cornea depends on its curvature and difference in refractive indexes between it and air. The interaction between axial length and corneal curvature has played a major role in compensatory adjustments of the optical components of the eye towards attaining emmetropic state. [5] The aim of this study is to determine the role of axial length and corneal curvature in refractive state categorization in people coming to OPD.

## MATERIALS AND METHODS:

After obtaining institutional ethical clearance [TMCHRC /Surg/2021/IEC Protocol-16/29 dated 19/07/2021] this observational study was carried out over a period of six months. Sample size calculation was done based on a previous study conducted by Denniston et al, the proportion of population suffering from refractive error is 80% in Asian population. [6] So, p = 80 % Using Cochran's formula for sample size (n) calculation, $n = (4 \times p \times q) / e^2$, Where, p = 80 % = 0.8, q = (1 - p ) = 0.2. Taking e, absolute error of 10%, e = 0.10. Hence, n = (4 x 0.8 x 0.2) / (0.10 x 0.10) = 64. As the calculated sample size appears to be small, it was decided to consider double the number of statistically calculated sample size, which comes around 128, rounding up the figure to 150. Hence, a total of 150 patients of either gender aged between 20-50 years were examined in outpatient department (OPD) basis in our tertiary care hospital after obtaining written informed consent.

Patients of either sex, age between 20 to 50 years and willing to be the part of the study were included in this study. All patients were subjected to examination of axial length and keratometry. Written informed consent was taken from the patients participating in the study. Patient with any media opacity, keratoconus, keratoglobus, nanophthalmos (small eyes with shortened axial length i.e 20 mm or less, high corneal curvature), microphthalmos, cornea plana, corneal infection, ocular trauma, post refractive surgery were excluded. (Figure 1) For Axial Length measurement, A-scan biometer (by Carl Zeuss Meditc AG, 0774 Jena, Germany) was used for axial length readings. The patient was seated comfortably with head upright and eyes in the primary position of gaze.

The sterilized probe and a drop of topical anaesthetic paracain (proparacaine 0.5%) were instilled in the patient's eye. The probe was carefully aligned perpendicularly to and highly applanating the cornea. The Axial Length displayed on screen and reading was taken.

Topcon KR 800 keratometer was used to assess corneal curvature. The eye piece was adjusted for the examiner's refractive status. The patient is seated comfortably in front of the instrument with forehead on headrest and chin fitting into the chin rest. The examiner will see the mires through eyepiece while the patient is asked to fixate on the reflection of his/her own eye. The blurred mires are cleared by focusing knob. The minus signs are superimposed by the vertical power drum and the plus signs by the horizontal power drum. The measurements were taken. Categorization will be done based on Emmetropia <= +/-0.50 DS, Myopia > -0.50 DS, Hyperopia > +0.50 DS.

**Statistical analysis:**

The two parameters i.e. refractive error and corneal curvature was statistically analyzed by students't' test. The relationship thus obtained can be considered as: NS (not significant) –p>0.05, S (significant)–0.01<p<0.05, HS (highly significant) – p<0.01.

**RESULTS:**

Out of total 150 (100%) participants, 83 (55.3%) were females and 67 (44.7%) were males. mean age group of participants was 30.38 ± 8.239 (mean ± SD) years. 41(27.3%) were emmetropia, 19 (12.7%) hypermetropia, 90 (60.0%) myopia were the refractive errors for right and left eye respectively as shown in (Figure 2). Right eye axial length has negative correlation with right and left eye power. Similarly, the left eye axial length is also having negative correlation with right and left eye power. Right eye K1and right eye K2 is having negative correlation with right and left eye power. Left eye K1 is having positive correlation with right and left eye power while Left eye K2 is having negative correlation with right and left eye power.

**DISCUSSION:**

Based on our study results except for the steep meridian of the anterior corneal surface (K2) all other parameters like flat meridian of the anterior corneal surface (K1), axial length and power are significantly associated and helps for categorization of refractive status. Based on Pearson correlation study, the results showed that right eye axial length has negative correlation with right and left eye power. Similarly, the left eye axial length is also having negative correlation with right and left eye power. Right eye K1and K2 is having negative correlation with right and left eye power. Left eye K2 is having negative correlation with right and left eye power. In our study we found that Left eye K1 is having positive correlation with right and left eye power. We would recommend to have further larger number of sample size to understand this correlation. As we move from myopic to hyperopic refractive error, the axial length of both eyes decreases proportionately and is seen in various studies also. Koomson et al, in his study showed that young adults had larger axial length.[7] Cheng et al in his study showed that the axial length in myopic patients was found to be relatively higher than in hyperopes. [8] Fan et al in his study showed that, the refractive status is negatively correlated with axial length in Chinese university students. However, the correlation coefficient was found to be greater in among moderate to high myopia than in those with low hyperopia to emmetropia. [9] Hashemi et al, in his study observed that increase in the axial length is observed, which was greater for highly myopic eyes among Japanese adults. [10]

Ohsugi H et al in his study on Japanese patients showed there is an increase in the axial length, which was greater for highly myopic eyes.[11] Wang et al in his study observed that, there was an increase in axial length as the refractive error increased among his study population. [12] One should understand the basic principle that in myopia images are formed in front of the retina. The myopic refractive error is found to be in close association with elongation of eyeball i.e. increased axial length. Comparably in hyperopia, the shortening of eyeball i.e. decreased axial length thus image is formed behind the retina. Mainstone et al in his study did not find any significant relation between refractive errors of both eyes and axial length. [13] There are possible disparities observed among several studies on axial length and refractive error which may be due to differences in age groups, different range of refractive errors, sample size, the patients involved from various populations and different ethnicities.

**Limitation of the study:**

Although in this study we tried to include maximum number of patients, there is a need of multicentric larger population so that various geographical patients will be included and final conclusion can be derived.

**CONCLUSION:**

Myopic have higher axial length in comparison to emmetropia patients while hypermetropia patients had lower axial length of both the eyes. For both eyes, the flat meridian of the anterior corneal surface (K1) was found lesser in hypermetropia in comparison to emmetropia and myopia but overall, it was highest in emmetropia. For both eyes, the steep meridian of the anterior corneal surface (K2) was found almost similar in dimension irrespective of refractive error. Right eye axial length has negative correlation with right and left eye power. Similarly, the left eye axial length is also having negative correlation with right and left eye power. Right eye K1and right eye K2 is having negative correlation with right and left eye power. Left eye K1 is having positive correlation with right and left eye power while Left eye K2 is having negative correlation with right and left eye power.

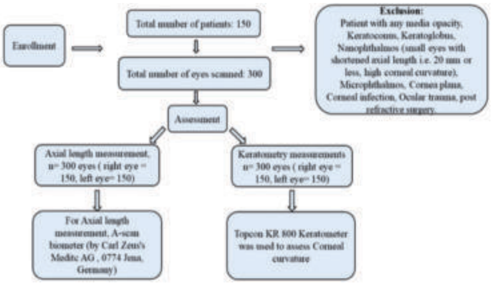


**Figure 1: Consort Diagram**

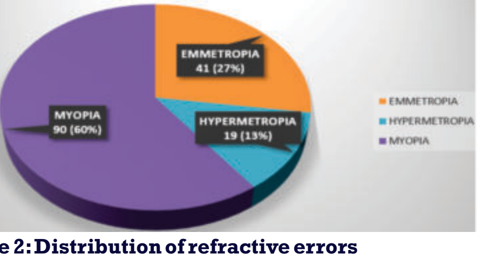


**Figure 2: Distribution of refractive errors**

**Table 1:** Mean, standard deviation, p value of K1 and K2, axial length and power of the both eyes and its association with categorization of refractive status.

| Anova test | (Mean ± Std. Deviation) | Minimum | Maximum | p value | Association |
|---|---|---|---|---|---|
| Re Keratometry K1 | 42.67 ± 1.744 | 40 | 49 | 0.019 | Significant |
| Re Keratometry K2 | 43.74 ± 1.632 | 42 | 50 | 0.310 | Not significant |
| Re Axial Length | 23.92 ± 1.303 | 21 | 26 | 0.000 | Significant |
| RE POWER | 2.297 ± 1.79 | - 6.5 | + 0.5 | 0.000 | Significant |
| Le Keratometry K1 | 42.63 ± 1.665 | 40 | 49 | 0.043 | Significant |
| Le Keratometry K2 | 43.67 ± 1.801 | 41 | 50 | 0.218 | Not significant |
| LE AXIAL LENGTH | 23.85 ± 1.236 | 21 | 26 | 0.000 | Significant |
| LE POWER | 4.52 ± 2.02 | -7.0 | + 0.75 | 0.000 | Significant |

RE=Right eye, Le= Left eye, K1= flat meridian of the anterior corneal surface, K2= Steep meridian of the anterior corneal surface p value less than 0.05 is considered as significant.

Table 2 shows the mean and standard deviation of K1, K2 and axial length among emmetropia, hypermetropia and myopic patients.

**Table 2: Mean, standard deviation of K1, K2 and axial length of all patients.**

| | | Right eye | Left eye |
|---|---|---|---|
| Emmetropia | KERATOMETRY K1 | 43.26 ± 1.42 | 43.14 ± 1.34 |
| | KERATOMETRY K2 | 43.97 ± 1.35 | 43.98 ± 1.53 |
| | AXIAL LENGTH | 23.16 ± 0.72 | 23.23 ± 0.71 |
| Hypermetropia | KERATOMETRY K1 | 41.94 ± 0.55 | 41.88 ± 0.30 |
| | KERATOMETRY K2 | 43.21 ± 0.21 | 42.96 ± 0.21 |
| | AXIAL LENGTH | 22.26 ± 0.98 | 22.53 ± 0.80 |
| Myopia | KERATOMETRY K1 | 42.48 ± 1.90 | 42.55 ± 1.89 |
| | KERATOMETRY K2 | 43.73 ± 1.78 | 43.67 ± 1.93 |
| | AXIAL LENGTH | 24.41 ± 1.05 | 24.34 ± 1.07 |

**Table 3: shows the correlation between K1, K2 axial length and power between right and left eye.**

| Pearsons Correlation | Age | Re Keratometry K1 | Re Keratometry K2 | Re Axial Length | Re Refractive Error | Re Power | Le Keratometry K1 | Le Keratometry K2 | Le Axial Length | Le Refractive Error | Le Power |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 1 | -.208 | -.215 | -.006 | .388 | .698 | -.063 | -.226 | -.009 | .388 | .850 |
| Re Keratometry K1 | -.208 | 1 | .906 | -.570 | -.202 | -.361 | -.076 | .861 | -.541 | -.202 | -.374 |
| Re Keratometry K2 | -.215 | .906 | 1 | -.505 | -.062 | -.311 | -.035 | .938 | -.486 | -.062 | -.305 |
| Re Axial Length | -.006 | -.570 | -.505 | 1 | .469 | -.557 | .142 | -.429 | .980 | .469 | -.473 |
| Re Refravtive Error | .388 | -.202 | -.062 | .469 | 1 | .731 | .136 | -.003 | .448 | 1.000 | .909 |
| Re Power | .698 | -.361 | -.311 | -.557 | .731 | 1 | .278 | -.208 | -.557 | .731 | .940 |
| Le Keratometry K1 | -.063 | -.076 | -.035 | .142 | .136 | .278 | 1 | -.002 | .148 | .136 | .210 |
| Le Keratometry K2 | -.226 | .861 | .938 | -.429 | -.003 | -.208 | -.002 | 1 | -.397 | -.003 | -.258 |
| Le Axial Length | -.009 | -.541 | -.486 | .980 | .448 | -.557 | .148 | -.397 | 1 | .448 | -.473 |
| Le Refractive Error | .388 | -.202 | -.062 | .469 | 1.000 | .731 | .136 | -.003 | .448 | 1 | .909 |
| Le Power | .850 | -.374 | -.305 | -.473 | .909 | .940 | .210 | -.258 | -.473 | .909 | 1 |

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