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# Comparism between Keratometric and Subjective Astigmatic Correction in a Black Population

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## Abstract

This study was carried out to compare keratometric and subjective astigmatic corrections. The method involved the examination of one hundred (100) subjects aged between 16 – 35 years with mean age of 22.74±4.55. The sample population comprised of fifty (50) males and fifty (50) females who were all Astigmats and had no history of any systemic/ocular pathologies and ocular surgery. The subjective correction was determined with static retinoscopic and subjective refractive techniques using the Jackson cross cylinder (JCC). The keratometric measurement was done with the Bausch and Laumb (B&L) keratometer. The result obtained revealed that the observed mean Astigmatic reading with the B&L keratometer was -0.858±0.629 while that of subjective was -1.20±0.79, and there was a significant difference between the two methods (subjective and keratometric) using the paired t – test ($t = 5.787$, $p < 0.05$). There was no significant difference between keratometric or subjective readings ($p>0.05$) which implied that either of these two methods could be used to estimate patients astigmatic correction.

**Keywords**: Astigmatism, Keratometric Readings, Subjective Refraction.

## INTRODUCTION

Astigmatism is a refractive condition in which the optical system of the eye is incapable of forming a point image of an object. This is due to the variation in converging power of the principal meridians of the optical surface of the cornea and lens. The total converging power of the human eye is 60.00 D and the Cornea, which is the main refractive element, contributes $^2/_3$ (40.00 D) of this. The Lens contributes approximately 12.00 D and the Aqueous & Vitreous approximately 8.00 D (Sridhar, 2018; Goyal et al., 2018). Thus clinically, the cornea contributes greater amount of astigmatism (Corneal Astigmatism) than the lens (Lenticular Astigmatism).

This is because the cornea is more ovally shaped than the lens. The cornea surface consists of two major meridians (one being of greatest power and the other of least power) and these meridians are separated by the interval of sturm. The amount of irregularity which exist between the two meridians is a measure of the degree of astigmatism which exist in that particular eye. It is worthy of note that many corneas are aspherical and hence contributes small amount of astigmatism of at least 0.25 D. This is termed physiological astigmatism and most times it is asymptomatic (Sridhar, 2018; Goyal et al., 2018; Grosvemor, 2002).

Astigmatism can be classified according to the power of the meridian with greatest converging power. Thus, it could be 'with the rule' (WTR) astigmatism in which the cornea is steeper at the vertical than the horizontal meridian; Or 'against the rule' (ATR) astigmatism in which the horizontal meridian has the greatest converging power than the vertical. Clinically, ATR astigmatism is less common than the WTR Astigmatism. In both types of Astigmatism, the two principal meridians (90 & 180) are positioned 90 degrees apart (regular astigmatism). However, in some cases, the difference between the two principal meridians could be less than 90 degrees apart (oblique astigmatism) (Hashemi et al., 2015; Yang et al., 2022). The signs/symptoms of this condition are characterized by transient blurry vision, squinting, head tilt, headaches and itching (Fotouhi et al., 2011).

The amount of corneal astigmatism along with the location of the meridian of least/greatest refraction can be determined with the aid of a Keratometer; while the total astigmatism is determined with the 'subjective refraction'. Astigmatism can be induced by some factors including age, trauma, surgery, pterygium, etc. And it has been well documented that females have steeper corneas than the males because of the smallness of the corneas in females (smaller eyeballs) than males (larger eye balls) (Yang et al., 2022; Fotouhi et al. 2011; Osaki et al., 2016). It is worthy of note that some studies have established a relationship between Keratometric and Refractive Astigmatism (Fotouhi et al. 2011; Osaki et al., 2016; Orucoghi et al., 2015; Casagrande et al., 2014).

## MATERIALS AND METHODS

### Study population

A randomized, double-masked, multicentre, and actively-controlled prospective study was carried out. The sample population of one hundred (100) students of University of Benin, Edo State, were aged between 16 – 35 years with mean age of 22.74±4.55. The population was composed of fifty (50) males and fifty (50) females, who were all astigmatic and had no history of any systemic or ocular pathologies such as keratoconus, ptergyium, keratoglobulus, ptosis, abnormal palpebral aperture and ocular surgery. Materials used include Snelle's Chart, Direct Ophthalmoscope, Retinoscope, Complete Trial Lens set, B&L Keratometer.

### Astigmatic Measurements

The astigmatic measurements were done using the Keratometric and Subjective Refraction techniques. The Keratometric reading was first obtained for each subject using the Bausch & Lomb (B&L) Keratometer calibrated in 0.25 D Step. This was by focusing the mires of the Keratometer on the patient's central cornea and then align the positive sign (+) and negative sign (-) and the readings noted. Thereafter, values for the subjective refraction were obtained by first determining the static retinoscopic finding with the Hiene retinoscope before the results were refined with the Jackson cross cylinder (JCC) (Furlan et al., 2009; Xiong et al., 2019; Chu and Kee, 2015; Zhao et al., 2021).

### Data Analysis

The data obtained from this questionnaire study was analyzed using Statistical Package for Social Sciences (SPSS) version 22.0.

## RESULTS

The data were generated from the readings collated from the hundred (100) participants of fifty (50) males and fifty (50) females aged between 18 – 35 years. The mean age for males and females were 23.04±3.28 and 22.74±4.55 respectively. The results from the Subjective and Keratometric readings are presented in the tables below: -

**TABLE I:** Mean Age Distribution of Mean Subjective and Keratometric Astigmatic Readings of Male Participants in the Sample Population.

| AGE RANGE | MEAN AGE | MEAN SUBJECTIVE READING | MEAN KERATOMETRIC READING |
|---|---|---|---|
| 16-19 | 17.545±1.128 | -1.295±0.986 | -1.523±0.925 |
| 20-23 | 21.353±1.115 | -0.779±0.432 | -1.250±0.9013 |
| 24-27 | 25.57±1.342 | -1.017±0.668 | -1.667±0.931 |
| 28-31 | 28.667±0.516 | -1.474±1.120 | -1.667±0.646 |
| 32-35 | 33.00±17.546 | -0.750±0.354 | -0.6250±0.530 |

The mean age for the male participants was 23.04±4.328; and the mean values for Subjective and Keratometric readings were -1.065±0.747 and -1.397±0.9310 respectively, showing that the Keratometric readings were slightly higher than the Subjective reading. But in comparing the means between the two measurements, there was a significant difference using the paired t-test ($t = 3.362$, $P = 0.002$) and the correlation between the measurements was also significant with the Pearson Correlation Coefficient ($r = 0.673$, $P < 0.05$).

**TABLE 2:** Mean Age Distribution of Mean Subjective and Keratometric Astigmatic Readings of Female Participants in the Sample Population

| AGE RANGE | MEAN AGE | MEAN SUBJECTIVE READING | MEAN KERATOMETRIC READING |
|---|---|---|---|
| 16-19 | 17.545±0.934 | -0.591±0.2311 | -1.115±0.8114 |
| 20-23 | 20.823±1.074 | -0.544±0.296 | -0.986±0.543 |
| 24-27 | 24.643±1.393 | -0.929±0.558 | -1.045±0.518 |
| 28-31 | 29.50±2.168 | -0.668±0.3028 | -1.125±0.628 |
| 32-35 | 34.00±1.414 | 0.000±0.707 | -0.50±0.35 |

The mean age was 22.74±4.55. And the mean values for Subjective and Keratometric readings (K-readings) were -0.655±0.43, and -1.028±0.599 respectively, indicating that the K-reading was slightly higher than the Subjective readings. But in comparing the means of the two measurements, there was a significant difference statistically using the paired t-test ($t = 4.936$, $P < 0.05$). Also, the correlation between the two measurements was significant statistically using the Pearson Correlation Coefficient ($r = 0.503$, $P < 0.05$).

The results also showed that there was a statistically significant difference in the Subjective and K-Measurements between the males and females using the unpaired t-test ($t_s = 3.326$. $t_k = 2.359$, $P < 0.05$).

## DISCUSSION

The result obtained from the study indicated that the observed mean K-reading was slightly higher than the Subjective readings in both males and female subjects. And statistically there was a significant difference between the mean value for the cylinders as measured by both subjective refraction and keratometry; as compared with the mean difference of 0.3423 DC using the paired t-test ($t=5.787$, $p<0.05$). This was due to the fact that Keratometry measures only the astigmatism due to the anterior corneal surface while subjective refraction measures astigmatism extending from the anterior cornea to the perceptual levels at the visual cortex. It was for this reason that the opinion of the subjects, were sought in determining the total amount of astigmatism which they accepted (Vasudevan et al., 2016).

The Keratometer is usually calibrated with an index of refraction of 1.3375, in order to take into consideration, the negative refraction, between 5.00D and 6.00 D, at the back surface of the Cornea. Thus, since the true index of refraction of Cornea was 1.376, the amount of corneal astigmatism measured by the Keratometer was approximately 10% less than the true amount of astigmatism due to refraction at the front surface of the Cornea (Fan et al., 2004).

Pearson's moment correlation coefficient test revealed a strong correlation between the mean cylinders as measured by both methods. The correlation coefficient was ($r = 0.672$ and $p<0.05$) and this was in line with earlier works that showed the correlation between refraction and corneal topography in idiopathic and surgically induced astigmatism (Orucoghi et al., 2015). There was a significant correlation with the slope of regression line

= 0.60 and r = 0.35. Similarly, a paired t-test revealed a significant difference that existed between the mean cylinders of subjective refraction and keratometry values in males/females ($t = 3.362$: $t = 5.009$. $p<0.05$). Pearson's correlation also revealed a strong correlation between the cylindrical values as measured by the two methods in both the males and females using the person's correlation coefficient ($r = 0.673$: $r=0.538$ $p<0.01$) which was found to be in line with the general findings.

Also, a significant difference was found to exist between the mean cylinders of male and female as measured by subjective refraction and Keratometric technique using the unpaired t-test ($t=3.326$. $t=2.359$ $p<0.05$). This can be explained by the report of Nemeth *et al.,* (2013) who reported that females have steeper corneas than males and explained that these differences appear to occur because females have smaller eyes which he believed to be as a result of genetic make up. Though Zhang et al. (2017) found no difference between the sexes but supported the claim by Kanclerz et al. (2023) that men are more likely than women to have refractive astigmatism greater than 2.00 D.

## CONCLUSION

The result showed that there is no significant difference ($p>0.05$) between the readings obtained with the two methods (subjective a and keratometric astigmatism). Thus, either of the two methods could be used to estimate patient's astigmatic correction.

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