Original Article

A Cross-Sectional Study On Refractive Error In Relation To Corneal Curvature Among Adults With Refractive Error In A Tertiary Care Center

Dr. M.Mulla Meena kumari[1] , Dr. C.Indhu[2] , Dr. K.Namitha Bhuvaneswari[3]

[1]Final year Postgraduate, Ophthalmology
[2]Consultant of Department of Ophthalmology)
[3]Professor of Department of Ophthalmology, MMCH & RI)
DOI: 10.47750/pnr.2022.13.S04.261

Abstract

Background: The most frequent worldwide cause of visual impairment is refractive errors. Important biometric variables impacting refractive errors include changes in axial length (AL) and corneal curvature (CC).

Material and Methods: A cross sectional study was conducted among adult patients with refractory error in OPD of Ophthalmology. 400 patients were selected using a convenient sampling technique and they were examined for refraction using an auto refractor and corneal curvature using an auto keratometer. Data were analysed using SPSS software by descriptive and inferential statistics.

Results: There was a significant positive correlation between spherical refractory error and corneal curvature on the right side (0.121) and left side (0.211).

Conclusion: It might be determining factor among patients with refractive errors for the choice of treatment.

Keywords: Refractive error, Corneal curvature, Hyperopia, Myopia, Cross sectional study.

Introduction

The most frequent worldwide cause of visual impairment is refractive errors. Due to the structure of the eye, refractive error prevents light from being focused correctly on the retina. (1)Myopia (nearsightedness), which is defined as difficulty seeing distant objects clearly, hyperopia, which is difficulty seeing close objects clearly, astigmatism, which is defined as distorted vision caused by an irregularly curved cornea, and presbyopia, which makes it difficult to read or see objects far away related to aging process are the four most common refractive errors. Double vision, headaches, and eye strain may also be present. Surgical correction, contact lenses, or spectacles are used to correct refractive defects. One to two billion people around the world are thought to have refractive defects.(2) It was estimated that nearly 153 million individuals had vision impairment due to uncorrected refractive errors globally by World Health Organization. (3)

A systematic review and meta-analysis by Yekts A et al(4) described that refractive errors (77.2%[95% CI: 73.4% - 81%])were the common cause of visual impairment globally.

Globally, the rates vary, with 80% of Asians and 25% of Europeans being impacted. The most prevalent condition is myopia.(5) Rates for adults range from 15% to 49%, while those for kids range from 1.2 to 42%.(6) Elderly people and young children are more frequently afflicted by hyperopia.(7) The majority of adults over 35 experience presbyopia.

Sheeladevi S et al(8) in a systematic review found that 53.1% of prevalence of RE of at least 0.50 D of spherical equivalent ametropia which myopia and hyperopia were 27.7% and 22.9%, respectively among Indian population.

Important biometric variables impacting refractive errors include changes in axial length (AL) and corneal curvature (CC). (9)

The type of ametropia, its severity, and the shape of the cornea are taken into consideration by the ophthalmologist when determining which procedure is best for the patient's treatment needs, such as LASIK (Laser-Assisted in situ Keratomileusis), LASEK (Laser Assisted Subepithelial Keratectomy), or PRK (Photorefractive Keratectomy). Knowing in detail the relationship between refractive error and corneal curvature of the eye, if found, would be quite interesting and very useful because it will open a number of gates in the future for study on this important topic. As it is very clear that refractive errors have a significant burden on society, their complications, and dependence of the mode of treatment upon various ocular biometers such as corneal curvature. (10) So, this study was an attempt to determine the relationship between refractory error and corneal curvature of the eye.

Objective

- To determine the correlation between refractive error and corneal curvature of the eye.

Material and Methods

- Study design
  - A cross-sectional study
- Study area
  - Department of Ophthalmology
- Study duration
  - Six months (May – September 2022)
- Study population
  - Patients aged 20 – 40 years attending Ophthalmology OPD with refractive error
- Inclusion criteria
  - Patients aged 20 – 40 years.
  - Patients with refractive error – myopia and hypermetropia
- Exclusion criteria
  - Participants with other ocular illnesses like infections, and glaucoma.
  - Participants not willing to give consent
- Sampling technique
  - Convenient sampling
- Sample size
  - Sample size was calculated using formula $4pq/d^2$ (p = prevalence, q = (1 - p), d = absolute precision). Based on the proportion of 51.8% of myopic refractory error by Arora J et al the final sample size estimated was 400. (5% absolute precision, 80% power)
- Study instrument
  - A semi-structured questionnaire
  - Auto refractor
  - Auto keratometer

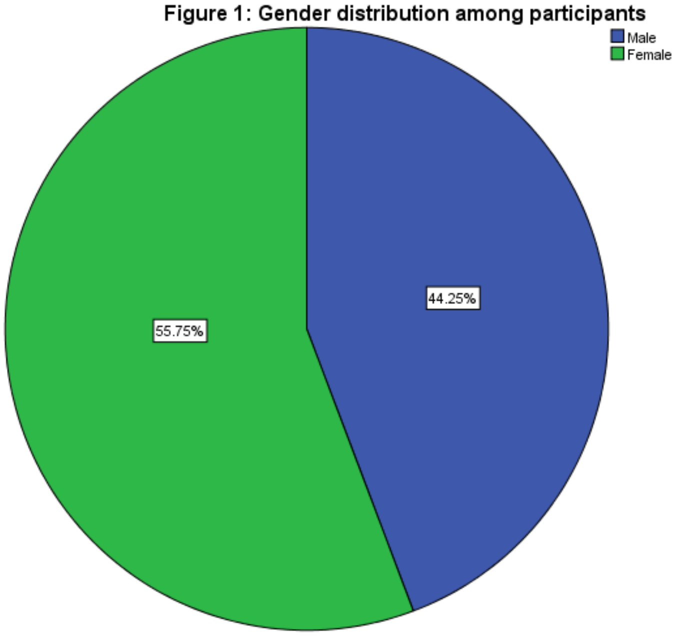
- By taking paired readings in two orthogonal meridia during keratometry, the central corneal curvature can be assessed manually or automatically. Take the mean of three reading pairs that include the axes. Keratometry in millimetres = 337.5/corneal power in dioptres (D) (where 337.5 is the hypothetical refractive index of the cornea). (11)

- Data collection
  - Data was collected in the Department of Ophthalmology using semi-structured questionnaire among participants by interview method after getting their consent. General and local examination of both was done and ocular parameters were recorded. The type of degree of refractory error was assessed by an autorefractor and the auto keratometer was used to measure the curvature of the anterior surface of the cornea.
  - Auto refractor
    - A subject's refractive error is measured objectively using a computer-controlled device. It is an extremely quick and easy method. The individual is forced to sit and set his chin on a chin rest after being administered a cycloplegic drug, which is used to relax ciliary muscles. The individual is instructed to stare inside the device at a picture inside with one eye at a time. As the equipment gathers readings, the image shifts in and out of focus. The gadget takes several readings, averages them, and in a matter of seconds determines the kind and severity of the refractive error. When treating non-communicable patients like infants and those with disabilities, is more helpful. (10)
  - Auto keratometer
    - An auto keratometer, also known as an ophthalmometer, is a diagnostic tool used to gauge the anterior surface of the cornea's curvature. Hermann Von Helmholtz, a German physiologist, created it in 1880, however, an earlier version was created in 1796 by Jesse Ramsden and Everard Home. It also goes by the name Opthalmometer. The keratometer evaluates the cornea's measurements at various spots, which can be used to estimate the degree of correction, the corrective prescription, and whether concave or convex lenses are needed to correct vision to a usable level. (10)
  - USED FORMULA: R = 2 DI/O (where R is the radius of curvature, D is the separation between the reflecting surface and the object, I is the size of the image, and O is the size of the object).
- Data analysis
  - Data was entered in Microsoft excel 2019 and analyzed using software SPSS (Statistical Package of Social Sciences) version 21. Continuous variables and categorical variables were interpreted using frequencies (mean±SD) and proportions (%). The Pearson correlation was used to determine the relationship between refractory error and corneal curvature of the eye and a p-value less than 0.05 was considered a statistically significant value.

Results

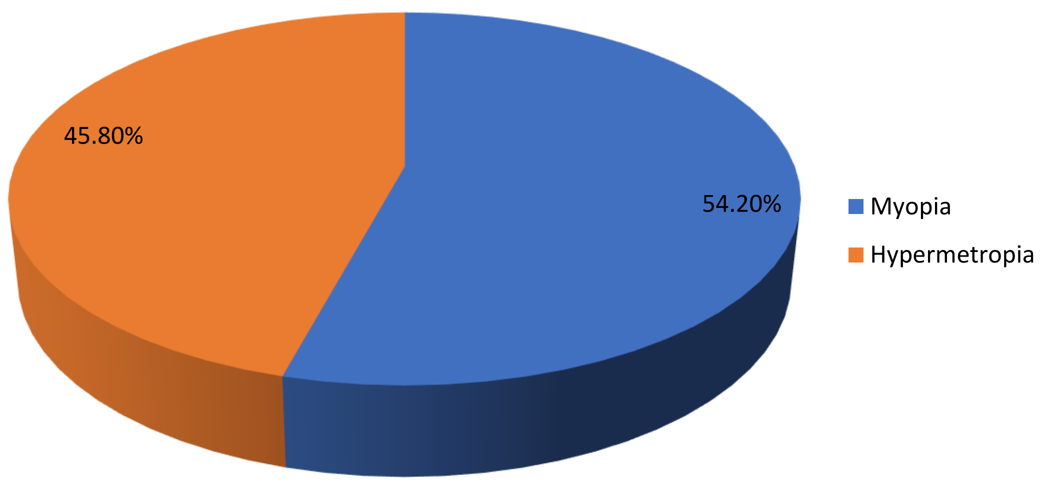
This study was conducted among 400 participants and 800 eyes. 55.75% of the participants were females and the rest of them were males (44.25%).

Figure 1: Gender distribution among participants



The mean age of participants was 29.46 ±5.174 years ranging from 20 – 40 years. 45.8% of them were hypermetropic and 54.2% of them had myopic refractive errors.

Figure 2: Refractive error among participants



The mean corneal curvature of the right eye was 43.26 ±0.389 and the left eye was 43.08± 0.455.

Table 1: Baseline Characteristics of participants			
S No	Variables	Mean	SD
1	Age	29.46	5.174

2	Spherical refractive error Right eye	-0.534	1.946
3	Spherical refractive error Left eye	-0.116	1.946
4	Corneal curvature Right eye	43.26	0.389
5	Corneal curvature left eye	43.08	0.455

The age group exhibits a negative correlation between spherical refractive error and corneal curvature. There was a significant positive correlation between spherical refractory error and corneal curvature on the right side (0.121) and left side (0.211). This implies that the corneal curvature increases and spherical refractory error also increases.

Table 2: Correlation coefficient (r) of variables

S No	Variables	Age	Spherical refractive error Right eye	Spherical refractive error Left eye	Corneal curvature Right eye	Corneal curvature of left eye
1	Age	1	**-0.198**	-0.004	-0.037	**-0.274**
	p-value		0.001	0.933	0.465	0.001
2	Spherical refractive error Right eye	-0.179	1	**0.466**	**0.121**	**0.296**
	p-value	0.001		0.001	0.015	0.001
3	Spherical refractive error Left eye	-0.026	**0.466**	1	0.004	**0.211**
	p-value	0.603	0.001		0.930	0.001
4	Corneal curvature Right eye	-0.037	**0.121**	0.004	1	**0.137**
	p-value	0.465	0.015	0.930		0.006
5	Corneal curvature of left eye	**-0.274**	**0.296**	**0.211**	**0.137**	1
	p-value	0.001	0.001	0.001	0.006	

Discussion

This study was conducted to know the relation between refractive error and corneal curvature among participants with refractive error. The study found that there was a significant positive correlation between spherical refractive error and corneal curvature on the right side (0.121) and left side (0.211).

In Patiala, Arora J et al(10) discovered a statistically significant positive link between spherical refractive error and corneal curvature in both the right eye (r=0.159, p0.01) and the left eye (r=0.184, p0.01) among adult participants with refractory error. It implies that when our refractive error progresses from myopic to hyperopic, the corneal curvature does as well. This result exhibits similar results to our study.

Meiktila et al(12) study in Myanmar found that the CC was positively correlated with the refraction of spherical equivalent diopters which was similar to our study results.

The same findings were made by Grosvenor and Scott(13), who found that there was a statistically significant link between refractive error and corneal curvature.

Wang et al.(14) also demonstrated that corneal curvature reduces with increasing refractive error. The ocular diametrical ratio determines the refractive condition.

Refractive error and corneal curvature do not appear to be significantly correlated, according to Mainstone et al(15) which varied from our study findings. It was discovered that axial length decreased as hyperopic refractive error increased (r = 0.753, p = 0.0001). Contrary to earlier studies for myopic eyes, which indicated a link between these two factors, corneal asphericity does not appear to be significantly correlated with refractive error for hyperopic eyes. The findings imply that there might be variations between myopic and hyperopic eyes in terms of the alterations to the anterior segment that takes place as refractive error develops.

After doing their investigation, Little et al(16) concluded that there was no significant relationship between corneal curvature and spherical refractive error (p=0.51). MSE refractive error and AL had a strong negative correlation (r=-0.91, p0.0001). Refractive error was unaffected by CC in a significant way (r=-0.11, p=0.51). Calculating the AL/CC ratio and comparing it to refractive error also demonstrated a significant correlation (r=-0.92, p0.0001)

Additionally, Bao et al(17) were unable to find any connection between corneal curvature and refractive error. Myopia may be attributed to scleral stretching and globe elongation rather than changes in corneal curvature or anterior chamber depth, as evidenced by the refractive error's significant high correlation with axial length (r=-0.586, P.001) but not with corneal curvature or anterior chamber depth.

Conclusion

The results thus obtained from this present study clearly establish the relationship of
corneal curvature with refractive error
The results thus obtained from this present study clearly establish the relationship of
corneal curvature with refractive error
The corneal curvature had an impact on spherical refractive error. It might be determining factor among patients with refractive errors for the choice of treatment. The other factors which influence refractive error can be studied further for the prevention and successful management of refractive errors.

Limitations

- The larger sample size might be considered for generalizing results.
- Axial length of cornea can be assessed to differentiate the relation of corneal curvature

References

1. Mohammed Dhaiban TS, Ummer FP, Khudadad H, Veettil ST. Types and Presentation of Refractive Error among Individuals Aged 0–30 Years: Hospital-Based Cross-Sectional Study, Yemen. Adv Med. 2021 Jul 5;2021:e5557761.

2. Refractive Errors | National Eye Institute [Internet]. [cited 2022 Sep 30]. Available from: https://www.nei.nih.gov/learn-about-eye-health/eye-conditions-and-diseases/refractive-errors

3. Blindness and vision impairment: Refractive errors [Internet]. [cited 2022 Sep 29]. Available from: https://www.who.int/news-room/questions-and-answers/item/blindness-and-vision-impairment-refractive-errors

4. Yekta A, Hooshmand E, Saatchi M, Ostadimoghaddam H, Asharlous A, Taheri A, et al. Global Prevalence and Causes of Visual Impairment and Blindness in Children: A Systematic Review and Meta-Analysis. J Curr Ophthalmol. 2022 Apr 16;34(1):1–15.

5. Epidemiology of myopia | Eye [Internet]. [cited 2022 Sep 30]. Available from: https://www.nature.com/articles/eye2013280

6. Pan CW, Ramamurthy D, Saw SM. Worldwide prevalence and risk factors for myopia. Ophthalmic Physiol Opt. 2012;32(1):3–16.

7. Castagno VD, Fassa AG, Carret MLV, Vilela MAP, Meucci RD. Hyperopia: a meta-analysis of prevalence and a review of associated factors among school-aged children. BMC Ophthalmol. 2014 Dec 23;14(1):163.

8. Sheeladevi S, Seelam B, Nukella PB, Borah RR, Ali R, Keay L. Prevalence of refractive errors, uncorrected refractive error, and presbyopia in adults in India: A systematic review. Indian J Ophthalmol. 2019 May;67(5):583–92.

9. Mallen EAH, Gammoh Y, Al-Bdour M, Sayegh FN. Refractive error and ocular biometry in Jordanian adults. Ophthalmic Physiol Opt J Br Coll Ophthalmic Opt Optom. 2005 Jul;25(4):302–9.

10. Arora J, Aneja P, Mehta P, Randhawa B, D S, Kumar A, et al. RELATION OF REFRACTIVE ERROR WITH CORNEAL CURVATURE OF THE EYE IN ADULT SUBJECTS WITH REFRACTIVE ERROR. J Evol Med Dent Sci. 2015 Jun 23;4:8846–55.

11. Cornea Curvature - an overview | ScienceDirect Topics [Internet]. [cited 2022 Sep 30]. Available from: https://www.sciencedirect.com/topics/nursing-and-health-professions/cornea-curvature

12. Warrier S, Wu HM, Newland HS, Muecke J, Selva D, Aung T, et al. Ocular biometry and determinants of refractive error in rural Myanmar: the Meiktila Eye Study. Br J Ophthalmol. 2008 Dec;92(12):1591–4.

13. Grosvenor T, Scott R. Role of the axial length/corneal radius ratio in determining the refractive state of the eye. Optom Vis Sci Off Publ Am Acad Optom. 1994 Sep;71(9):573–9.

14. Wang FR, Zhou XD, Zhou SZ. [A CT study of the relation between ocular axial biometry and refraction]. Zhonghua Yan Ke Za Zhi Chin J Ophthalmol. 1994 Jan;30(1):39–40.

15. Mainstone JC, Carney LG, Anderson CR, Clem PM, Stephensen AL, Wilson MD. Corneal shape in hyperopia. Clin Exp Optom. 1998 Jun;81(3):131–7.

16. Little JA, McClelland JF, Saunders KJ, Jackson A. The Relationship Between Axial Length, Refractive Error and Corneal Curvature in Children and Young Adults With Cerebral Palsy. Invest Ophthalmol Vis Sci. 2009 Apr 28;50(13):3965.

17. Bao FJ, Yu AY, Kassem W, Wang QM, Elsheikh A. Biometry of the cornea in myopic chinese patients. J Refract Surg Thorofare NJ 1995. 2011 May;27(5):345–55.