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ORIGINAL ARTICLE

RELATION OF REFRACTIVE ERROR WITH CORNEAL CURVATURE OF THE EYE IN ADULT SUBJECTS WITH REFRACTIVE ERROR

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ABSTRACT: BACKGROUND: The second most common reason for blindness worldwide is refractive error. Not only is the global burden of refractive error very high, but also increasing every day. A number of associated serious complications and the various modes of treatment aspect of the refractive errors, warrants the necessity to explore the various factors that have impact on them. The present study was done with the purpose of establishing the relation of refractive error with corneal curvature of the eye in adult subjects. This study was done on one thousand eyes, of five hundred adult cases, over a total period of 2 years. The cases included were of both sex's male and female, taken from Patiala and around Patiala. The subjects were recruited on the basis of inclusion criteria: refractive error- myopia and hyperopia, aged between 20-40 years. The subjects in our study included students of M.B.B.S. (Bachelor of Medicine and Bachelor of Surgery) and B.D.S. (Bachelor of Dental Sciences) and routine OPD (outpatient door) patients falling in the range of concern of my study. The instruments used in this study were: Auto refractor and Auto keratometer for measuring refractive error and corneal curvature respectively. Each subject was explained thoroughly about the whole procedure. Their informed written consent was also taken. General examination was done in each and every case. Thereafter local examination was done and the two concerned ocular parameters were recorded. The aim was to find in the subjects the type and degree of refractive error and corneal curvature and to find the relationship in between the two parameters. Statistical analysis was done of the data obtained. The results of our present study have showed that the spherical refractive error has statistically highly significant positive correlation with corneal curvature, in right eye ($r=0.159$, $p<0.01$) and in left eye ($r=0.184$, $p<0.01$). It means that as we progress from myopic to hyperopic refractive error accordingly the corneal curvature increases. In myopia or shortsightedness, image is formed in front of retina. Increase in myopic refractive error is found to be in close association with decreased corneal curvature. In hyperopia or long sightedness, image is formed behind the retina. Increased corneal curvature of the eyeball is found to be closely associated with hyperopia.

KEYWORDS: Corneal curvature, Hyperopia, Long sightedness, Myopia, Refractive error, Short sightedness.

INTRODUCTION: Blindness is one of the most significant social problems, with uncorrected refractive errors as the second major cause accounting for 19.7% of blindness and low vision. One third of the world's blind (About 15 million) are in SEAR (South East Asian region) and 50% of world's blind children live in this region.[1] The overall incidence in India has been reported to vary between 21% and 25% in patients attending eye outpatient departments.[2]

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The prevalence of refractive error specially myopia is currently attracting worldwide attention as many recent studies report dramatic increases over the last 20 years.[3] Global refractive errors have been estimated to affect 800 million to 2.3 billion people.[4]

Both genetic and environmental factors appear to contribute to the development of myopia.[5]

An association between myopia and socio-economic status and education level has also been observed.[6] There is strong evidence that genetic factors play a part in the etiology of myopia. It has been observed that identical twins show close agreement in their refractions whereas non-identical twins show little more agreement than control pairs of siblings.[7] Studies have highlighted associations between environmental factors such as near work and myopia. Several epidemiological studies have identified higher rates of myopia and progression amongst university students and length of time studying.[8,9] Occupations requiring intense close work (Microscopists, textilers) have also been associated with the development and progression of myopia.[10]

Like myopia, genetic factors appear to be the major determinant of hypermetropia.[11-12]

Ocular biometrics are among the most important factors affecting refractive errors.[13-15]

Changes in Axial Length (AL) and Corneal Curvature (CC) are important biometric factors affecting refractive errors[16-18]. Patients with myopia may also suffer certain complications, such as macular degeneration, retinal detachment[19] or glaucoma.[20]

Ophthalmologist decides which procedure best suits the treatment needs of the patient, like LASIK (Laser-Assisted in situ Keratomileusis)/LASEK (Laser Assisted Subepithelial Keratectomy)/ PRK (Photorefractive Keratectomy) , depending on the nature of ametropia, its intensity and the shape of the cornea.[21]

As it is very much clear that the great burden of refractive errors on the society, their complications and dependence of the mode of treatment upon various ocular biometers such as corneal shape, so knowing in detail the association of refractive error with corneal curvature of eye, if found any, would be quite interesting as well as very useful because it will open a number of gates in future for study on this important topic. Though lot of research has been done so far but the same has not been carried out here, in our region. Hence this study was carried out.

MATERIAL AND METHODS: With the permission of institutional ethical committee, this study was done with the purpose of establishing the relation between refractive error and corneal curvature in adult subjects.

SUBJECTS: This study was done on one thousand eyes, of five hundred adult cases, aged between 20-40 years, over a total period of 2 years. The cases included were of both sex- male and female, taken from Patiala and around Patiala. The subjects were recruited on the basis of inclusion criteria: refractive error- myopia and hyperopia, aged between 20-40 years. The subjects included in our study were students of M.B.B.S. and B.D.S. and routine OPD patients falling in the range of concern of my study. The instruments used in this study were: Auto refractor and Auto keratometer for measuring refractive error and corneal curvature respectively.

Each subject was explained thoroughly about the whole procedure. Their written consent had also been recorded. General examination was done in each and every case. Thereafter local examination was done and the two concerned ocular parameters were recorded.

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APPARATUS & PROCEDURE: Auto refractor or Automated Refractor is used to know the type and degree of refractive error. It is a computer-controlled machine that provides objective measurement of a subject's refractive error. It is a very quick and simple technique. After application of a cycloplegic agent, used to relax ciliary muscles, the subject is made to sit and place his chin on a chin rest. With one eye at a time, the subject is asked to look into the machine at a picture inside. The picture moves in and out of focus, as the machine takes readings. Several readings are taken, which the machine averages to give a diagnosis of the type and degree of refractive error within seconds. It is more useful while dealing with non-communicable patients like young children and one with disabilities.[22]

Auto keratometer or Opthalmometer is a diagnostic instrument used for measuring the curvature of anterior surface of Cornea. It was invented by German Physiologist Hermann Von Helmholtz in 1880 [although as earlier model was developed in 1796 by Jesse Ramsden and Everard Home]. It is also known as Opthalmometer.

The keratometer measures the dimensions of cornea at different points and helps to determine a proper corrective prescription, the degree of correction and whether concave or convex lenses are required to restore vision to an acceptable level.

The device is also frequently used to assist an eye surgeon in certain surgical procedures, enabling him to make precise incisions during cataract and other corrective eye surgeries.[23]

FORMULA USED: $R = 2\ DI/O$

(Where R = Radius of Curvature, D = Distance between reflecting surface and object, I = Image size, O = Object size).

Fig. 1: Autorefractometer or automated refractor

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Fig. 2: Autokeratometer or Opthalmometer

STATISTICAL ANALYSIS: The whole obtained data regarding the two parameters i.e. refractive error and corneal curvature was analyzed statistically, using 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: There were a total of 500 cases. 200 out of 500 i.e. 40% of total were males. The rest 300 cases i.e. 60% of total were females. 400 eyes out of 1000 i.e. 40% eyes were of male cases. Out of 1000 eyes, 600 i.e. 60% were of female cases.

Out of total 500 cases, 259 i.e., 51.8% cases were found to be myopes. 241 cases out of 500 i.e. 48.2% cases were found to be hyperopes. 518 eyes out of 1000 i.e., 51.8% eyes were having myopic refractive error. 482 eyes out of 1000 i.e. 48.2% were found to be hyperopes.

PARAMETERS	MEAN±S.D.	N
AGE (YRS)	39.19±13.14	500
RT SE (D)	-0.61±3.09	500
LT SE (D)	-0.50±2.97	500
RT CC (mm)	43.85±1.65	500
LT CC (mm)	43.69±1.73	500

Table 1: Showing Mean & Standard Deviations of Various Parameters of Cases

Level of Significance are shown as: *Significant ($0.01<p<0.05$) and **Highly Significant ($p<0.01$).

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It is observed that right eye refractive error has highly significant positive correlation with right eye corneal curvature (r =0.159, p<0.01) and left eye refractive error with left eye corneal curvature (r = 0.184, p<0.01).

	AGE	RT (SE)	LT (SE)	RT (CC)	LT (CC)
AGE	1	0.385**	0.372**	0.122**	0.186**
RT (SE)	0.385**	1	0.953**	0.159**	0.184**
LT (SE)	0.372**	0.953**	1	0.159**	0.179**
RT (CC)	0.122**	0.159**	0.159**	1	0.944**
LT (CC)	0.186**	0.184**	0.184**	0.944**	1

Table 2: Showing Coefficient of Correlation 'r' Between Various Parameters of Cases

Distribution of total number of eyes was done in 6 groups according to type and degree of refractive error. Group A includes 6 eyes with refractive error -12.00 D and onwards; Group B - 28 eyes, -12.00 to -8.00 D; Group C - 88 eyes, -8.00 to -4.00 D; Group D - 396 eyes, -4.00 to 0.00 D; Group E - 460 eyes, 0.00 to +4.00 D; Group F - 22 eyes, +4.00 to +8.00 D.

The mean value and S.D. of refractive error was calculated. In Group A, it was -15.75±1.255 D; in Group B, -9.49±0.890 D; in Group C, -5.22±1.030 D; in Group D, -1.80±1.139 D; in Group E, +1.63±0.947 D; in Group F, +5.60±1.030 D.

The mean and S.D. of corneal curvature was as - In Group A, 43.92±1.660mm; in Group B, 44.25±1.610mm, in Group C, 44.72±1.770 mm, in Group D, 44.89±1.620mm, in Group E, 44.51±1.670 mm, in Group F, 44.99±1.490mm.

DISCUSSION: The present study has revealed that the right eye spherical refractive error has statistically highly significant positive correlation with right eye corneal curvature (r=0.159, p<0.01). Also, the left eye spherical refractive error has highly significant positive correlation with left eye corneal curvature (r=0.184, p<0.01). It means that as we progress from myopic to hyperopic refractive error, accordingly the corneal curvature decreases.

This result is in accordance with the observations made in other studies like Curtin who came to the conclusion that in myopes the corneal curvature was found to be relatively on the lesser side. As the refractive error goes on increasing, corneal curvature also decreases.[24]

According to Cheng et al corneal curvature in myopes was found to be relatively less than in hyperopes.[25]

Also Grosvenor and Scott observed the same results that statistically highly significant correlation was present between refractive error & corneal curvature there.[26]

Wang et al also established the fact that as the refractive error increases, corneal curvature decreases.[27]

Carney et al established the same direct relationship between refractive error and corneal curvature. More the myopic refractive error, lesser becomes the corneal curvature and conversely, hyperopes were found to have relatively more corneal curvature.[28]

Goss et al came to the conclusion which states the direct relationship between refractive error and corneal curvature.[29]

Strang et al compared the corneal curvature in myopes and hyperopes and found the myopic corneal curvature to be on the lesser side.[30]

Chang et al from their study concluded significant relationship between refractive error and corneal curvature.[31]

Saw et al came to conclude that eyes with decreased corneal curvature tended towards myopia and conversely eyes with increased corneal curvature towards hyperopia.[32]

Touzeau et al conducted a study and established the fact that corneal curvature has the strongest correlation with spherical refractive error ($r=-0.91$, $p<0.001$).[33]

Atchison et al concluded that myopes had relatively lesser corneal curvature as compared to hyperopes.[34]

Llorente et al conducted a study on 24 myopic & 22 hyperopic eyes and concluded that corneal curvature in hyperopes (22.62±0.76 mm) was significantly more ($p<0.01$) than in myopes (25.16±1.23 mm).[35]

Song et al from their study came to the conclusion that corneal curvature increases rapidly till the age of 10 years. Then the growth slows down. But in myopes corneal curvature was more than in hyperopes ($p<0.001$).[36]

Chen et al suggested statistically highly significant correlation between refractive error and corneal curvature ($r=-0.645$, $p<0.001$).[37]

Fledelius and Goldschmidt evaluated the connecting link between refractive error and corneal curvature. Highly significant correlation ($p<0.001$) was established between the two parameters.[38]

Park et al came to the conclusion that shorter eyes i.e. eyes with increased corneal curvature show hyperopic shift while longer eyes i.e., eyes with decreased corneal curvature show myopic shift.[39]

Iyamu et al after their study on 70 cases who were with refractive error concluded that a highly significant negative correlation was present between spherical refractive error and corneal curvature ($r=-0.53$, $p<0.0001$).[40]

In myopia or shortsightedness, image is formed in front of the retina. Increase in myopic refractive error is found to be in close association with elongation of eyeball i.e. decreased corneal curvature. Similarly in hyperopia or long-sightedness, the finding of shortening of eyeball i.e. increased corneal curvature favors it as the image is formed behind the retina.

However, results of some authors were found to be in contrary to the results of present study regarding the relation between the two concerned ocular parameters. Like, Grosvenor and Goss from their study on refractive error & corneal curvature observed that myopic eyes had relatively steeper cornea than hyperopic eyes.[41]

Mainstone et al did not observe any significant relation between refractive error and corneal curvature.[42]

Grosvenor & Goss did not find any significant relation between the two parameters refractive error and corneal curvature.[43]

Little et al after conducting their study reached the conclusion that no significant correlation was present between spherical refractive error and corneal curvature ($p<0.51$).[44]

Also, Bao et al could not establish any significant relationship between refractive error and corneal curvature.[45]

Some variations in results among the concerned two ocular parameters across various studies are observed. Several reasons that may account for these differences among results are many,

such as differences in age groups, refractive error ranges, sample size, populations, ethnicities, statistical power of the studies and various methods of measurement of various ocular parameters.

CONCLUSION: The results thus obtained from this present study clearly establish the relationship of corneal curvature with refractive error. Also such significant correlations would certainly be helpful in recruitment of various jobs like military services, navy services, aviation/pilots, drivers, railways, traffic policemen and others in which accurate vision of the individual has vital importance. Utilization of such results, thus observed, also help in the various types of LASIKs as treatment of refractive error. It would be further interesting to know the various factors which may modify or influence either refractive error apart from corneal curvature, like nutritional, genetic and various metabolic disorders. Knowing the various factors affecting refractive errors provide us the ways how the complications of refractive errors can be prevented. In this way, this established correlation will become the basis of new researches ahead now onwards.

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