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Biometric Evaluation of Hypermetropia – Our Study

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ABSTRACT
Hypermetropia is that form of refractive error in which parallel rays of light are brought to a focus some distance behind the sentinent layer of the retina when the eyeis at rest; the image formed here is therefore made up of circles of diffusion of considerable size, and is consequently blurred. Keratometry and ascan biometry was done to find out the correlation between various parameters of biometry findings and amount of hypermetropia
Keywords: *Hypemetropia, facultative hypermetropia, biometry, keratometry, principal focus, a-scan, absolute hypermetropia, autorefractometer, accommodation, axial length.*

INTRODUCTION

Refractive errors may be of three main types:

1. The principal focus formed is situated behind the retina, it is hypermetropia
2. The principal focus formed is situated in front of retina, it is called myopia
3. No single focus is formed, it is called astigmatism[1][2]

Hyperopia has been less studied than myopia because of its lower prevalence in developed countries, relative stability, and difficulties in measuring its magnitude accurately in young subjects

Hypermetropia is that form of refractive error in which parallel rays of light are brought to a focus some distance behind the sentinent layer of the retina when the eyeis at rest;[3] the image formed here is therefore made up of circles of diffusion of considerable size, and is consequently blurred.[4][5]

In hypermetropic eye, the second principal focus lies behind the retina.

Biometry of the eye is the measurement of various dimensions of the eye and its components and their relationship. It consists of keratometric reading together with ultrasonic measurement of axial length, anterior chamber depth, thickness of crystalline lens.

Four basic parameters are necessary to calculate the power by using various formulae.

a. Keratometry reading in terms of dioptric power of the eye or in terms of radius of curvature with keratometer.

b. Axial length of the eye (by A. Scan Ultrasonography)

c. Anterior chamber depth (by A, Scan Ultrasonography)

d. A constant - Specific for each lens type and / or manufacturer.

MATERIALS AND METHOD

This study was conducted in the Department of Ophthalmology, M.K.C.G. Medical College& Hospital, Berhampur from the period of 1st September 2011 to 31st August 2013with the following objectives:

1. To measure the different biometric values like axial length, anterior chamber depth, lens thickness and corneal curvature in ametropic patients using keratometer and A scan machine.
2. To investigate the possible relationship between the biometric measures with the degree of refractive error.

After recording visual acuity, determination of refractive errors in all the eyes was done clinically as well as on autorefractometer by the same examiner. The clinical retraction was invariably done first so as to obviate any possible examiner bias in the study.

Retinoscopy was performed with the reflecting plane mirror retinoscope. It was done with the use of a tropicamide(0.8%) plus phenylephrine(5%) eye drops. Autorefraction and subjective verification was done only after the effect of the drug ceased. Cylinder power and axis were confirmed using Jackson's cross-cylinder, in subjective verification, for comparison purposes, the refraction values which gives the best possible visual acuity was recorded.

All the eyes included in the study had a corrected visual acuity of 6/6. On all the patients, autorefraction was done with Grand Seiko GR-2100. According to the refractive status patients were divided into myopic, hypermetropic and astigmatism group.

Kerametry was done using Bausch and Lomb Keratometer. Corneal curvature (in mm) in the horizontal and vertical meridian was measured. Mean value of curvature was calculated.

A scan was done using Appasamy A scan machine. Eight readings were taken. Mean axial length, ACD, lens thickness in each eye was noted down.

Statistical analysis was done with the help of Microsoft excel and Instat Graphpad(version 3.1). Clinical correlation statistics were done using Pearson correlation coefficient and analysis was done by linear regression method.

Retinoscopy

Subjective Correction:

SPH CYL AXIS (VA attainted)

RE:
LE:

Automated Refraction:

SPH CYL AXIS (VA attainted)
RE:
LE:

KERATOMETRY

Eye	Horizontal Corneal Curvature (mm)	Vertical Corneal Curvature (mm)	Mean (mm)
RE			
LE			

A SCAN

Eye	Mean AC depth (mm)	Mean Lens thickness (mm)	Mean Axial length (mm)
RE			
LE			

OBSERVATION AND DISCUSSION

Total no of 25 cases with 49 eyes were included in our study.

Table-1 Age Distribution in Hypermetropia

AGE(in years)	Number of cases	Percentage
10-19	10	20.40
20-29	2	4
30-39	3	6.12
40-49	26	53.06
50-60	8	16.32

In this study hypermetropia was more common in the age group of 40-49 and it was about 53.06%.

Table-2: Gender Distribution In Hypermetropia

Gender	No. of Cases	Percentage
Male	13	52
Female	12	48

Out of 49 cases 52% were male and 48% were female.

Table-3 Distribution of Degree of Hypermetropia

Degree of Hypermetropia	Number of Cases	Percentage
+0.5-1	30	61.22
+1.25-2	14	28.57
+2.25-3	4	8.16
+3.25-4	1	2.04
+4.25-5	0	0
+5.25-6	0	0

In this study we had taken mild to moderate cases of hypermetropia. Patients having 0.5- 1 D were more common and it was about 61.22% followed by 1.25-2 D which was about 28.57%.

Table-4 Variation of Axial Length in Hypermetropia

Degree of Hypermetropia	No. of Cases	Axial Length (mean in mm)	SD
+0.5-1	30	22.91	0.38
+1.25-2	14	22.09	0.48
+2.25-3	4	21.33	0.23
+3.25-4	1	20.56	0.00

Correlation coefficient

$r = -0.91$

$r^2 = 0.84$

P* = <0.0001 considered extremely significant.

The minimum value of axial length obtained in this study is 20.56 and the maximum value was 23.63.

Mean value was 22.50±0.72mm which was lower than the normal value.

Normal value for axial length we had taken as 24mm.

In this study we found that there was a negative correlation between degree of hypermetropia and axial length.

P*= <0.0001, which was highly significant.

Lourdes Llorenteet al[96] showed that The axial length (AL) of hyperopic eyes (22.62 ± 0.76 mm) was significantly lower (*p*<.001) than the axial length of myopic eyes (25.16 ± 1.23 mm).

Table-5 Variation of Anterior Chamber Depth (ACD) in Hypermetropia

Degree of Hypermetropia	Number of Cases	ACD(mean in mm)	SD
+0.5-1	30	3.08	0.18
+1.25-2	14	2.9	0.12
+2.25-3	4	2.8	0.03
+3.25-4	1	2.8	

The minimum value of anterior chamber depth obtained in this study is 2.79 and the maximum value obtained was 3.47 mm.

Cumulative mean of anterior chamber depth for all eyes was 2.99±0.18 mm

Shallow anterior chamber depth was seen in 2-6 D range of hypermetropia.

Correlation coefficient (r) = -0.4984

So we found that there was a negative correlation between ACD and degree of hypermetropia.

P value was 0.0003, considered extremely significant.

95% confidence interval: -0.6838 to -0.2525

Coefficient of determination (r squared) = 0.2484

Table-6 Variation of Lens Thickness in Hypermetropia

Degree of Hypermetropia	Number of Cases	Lens Thickness (mean in mm)	SD
+0.5-1	30	3.99	0.46
+1.25-2	14	4.35	0.10
+2.25-3	4	4.5	0.13
+3.25-4	1	4.5	

P*=0.54, which was not statistically significant.

Minimum value of lens thickness was 3.12 and maximum value was 4.81.

Mean value was 4.16±0.41 mm

There was no correlation of lens thickness with the degree of hypermetropia, rather it was related with the age.

There was increase in lens thickness as age advances.

Table-7 Variation of Corneal Curvature in Hypermetropia

Degree of Hypermetropia	Number of Cases	Corneal Curvature (mean in mm)	SD
+0.5-1	30	7.90	0.31
+1.25-2	14	7.85	0.15
+2.25-3	4	7.8	0.26
+3.25-4	1	8.18	

P*= >0.05 which is statistically insignificant.

The minimum value obtained in this study is 7.42 and the maximum value was 8.73. mm.

The mean value of radius of curvature was, 7.87±0.27mm for all range of myopia. This is more than the average mean in emmetropic population.16 eyes had corneal curvature less than 7.8 mm. 32 eyes had corneal curvature more than 7.8 mm. One eye had corneal curvature equal to 7.8mm.

Lourdes Llorente et al showed that more spherical shape of the hyperopic corneas versus a more prolate shape of the myopic ones. This difference was marginally significant.[96]

Aetiologically, hypermetropia may be axial, curvatural, index, positional and due to absence of lens.

1. ***Axial hypermetropia***

It is by far the commonest of all refractive anomalies, and indeed forms a stage in normal development.at birth practically all eyes are hypermetropic to the extent of 2.5 to 3.0 dioptres, and as the growth of body proceeds the antero-posterior axis lengthens until, when adolescence is passed, the eye should theoretically be emmetropic. As a matter of fact, it is found that in over 50% of the population emmetropia is not reached.

As a rule, the degree of shortening is not great and rarely exceeds 2 mm. Each millimetre of shortening represents approximately 3 dioptres of refractive change, and thus a hypermetropia of over 6 dioptres is uncommon.[6]

2. ***Curvatural hypermetropia***

It is the condition in which the curvature of cornea, lens or both is flatter than the normal, resulting in a decrease in the refractive power of the eye. About 1mm increase in radius of curvature results in 6 D of hypermetropia.

3. ***Index hypermetropia***

It occurs due to change in refractive index of the lens in old age. It may also occur in diabetics under treatment.

4. ***Positional hypermetropia***

Results from posteriorly placed lens.

5. ***Absence of crystalline lens:***

It may be either congenital or acquired, following surgical removal or posterior dislocation leads to aphakia, which is a condition of high hypermetropia.[7]

Optics in hypermetropia-

Whether the hypermetropia is due to a decrease in the length of the eye, a decrease of curvature, or to a change in refractive index, the optical effect is same: parallel rays come to a focus behind the retina and the diffusion circles which are formed here result in a blurred and indistinct image. Moreover, since the axis of the eye is shorter image is smaller than emmetropia.[8]

Components of hypermetropia

Hypermetropia is classified into manifest and latent hypermetropia. Manifest hypermetropia is defined as the strongest convex lens correction accepted for clear distance vision. Latent hypermetropia is the remainder of the hypermetropia which is masked by ciliary tone and involuntary accommodation. This may account for several dioptres, especially in children, for whom cycloplegic refraction is necessary to ascertain the full magnitude of refractive error.

Hypermetropia which can be overcome by accommodation is called *facultative*, while hypermetropia in excess of the amplitude of accommodation is called *absolute.*

Optics of cornea

The thickness of peripheral part of cornea is greater than that of axial region; former being an average of 0.66mm and the latter 0.523mm. Hence curvature of posterior corneal surface is a little greater than that of the anterior and cornea can be considered a weak concave lens. The refractive power of anterior surface of the cornea is nearly 49D of convergence and that of posterior surface nearly 6D of divergence. Total refractive power of cornea is therefore about +43D.

Optics of lens

The theoretical calculation of power of lens is difficult as there is no uniform refractive index throughout the lens. After simplication and hypothetically structured lens, power of lens is deduced to be about +19.0D.

Optical power of eye

The total optical power of eye can be derived from known powers of corneal and lenticular systems. A simple addition of these is inaccurate since the systems are separated from one another, thereby increasing the total effective power. It emerges that the power of the normal eye is slightly less than +60.0D.

Formation of retinal images

Rays passing through nodal point, which acts as optical centre of eye will not be refracted. Image obtained on retina will be inverted and diminished; it is reinverted psychologically in cerebral cortex.

SUMMARY AND CONCLUSION

In hypermetropia mean axial length was 22.50±0.72 mm which is below the normal value. We found that there negative correlation exist between axial length and degree of hypermetropia and p*=<0.0001 which is highly significant.

Cumulative mean of anterior chamber depth for all eyes in hypermetropia was 2.99±0.18 mm. Shallow anterior chamber depth is seen in 2-6 D range of hypermetropia. Correlation coefficient (r) = -0.4984. So we found that there is negative correlation between ACD and degree of hypermetropia.

Mean lens thickness were 4.16±0.41 mm in hypermetropia and . We did not find any relation of thickness of lens with the refractive error rather thickness increases with age.

The mean corneal curvature was 7.87±0.27mm in hypermetropia .We did not find any statistically significant relationship of corneal curvature with any of the refractive error.

Axial length was most important in determining refractive error and plays a major role in ocular biometry. As ACD, LT are components of axial length, separate models were calculated to assess which components were most influential in determining refraction.

Variation of corneal curvature with the degree of refractive error was not statistically significant.

The variation of anterior chamber was statistically significant in hypermetropia. Shallow AC is seen in moderate hypermetropia. In hazy media and cataract patient biometry plays an important role as we can calculate the IOL power and know the refractive status of the eye. In this study, we showed that correlation exists between biometric measures and degree of refractive error.

In this study we had used contact A scan which has its own limitation. So to overcome this IOL master should be used to get more accurate result.

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