Original article

Presbyopia and its anatomical and physiological variants

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Abstract

Aim: To study the various ocular anatomical and physiological parameters in presbyopia.

Materials and methods: We studied the various ocular anatomical and physiological parameters like corneal curvature (keratometry readings: K1 and K2), central corneal thickness (CCT), anterior chamber depth (ACD), lens thickness (LT) and axial length (AL) in 100 presbyopic patients between 35 - 55 years of age. The patients were divided into two age groups: I (35 – 44 years) and II (45-55 yrs). ACD, AL and LT were measured using an A-scan. CCT was measured with ultrasonic pachymetry.

Results: The CCT decreased (BE), LT increased and ACD decreased (RE) significantly with increasing age ($p < 0.05$). There was no significant difference in males and females. Nearly 3/4th of the total increase in lens thickness was responsible for the decrease in the anterior chamber depth and the rest, 1/4th, goes posteriorly. Corneal curvature and AL showed no significant change with age.

Conclusions: The mean of CCT decreased significantly with advancing age. As age increased, the mean value of lens thickness increased and anterior chamber depth decreased. Nearly 3/4th of total increase in LT was anteriorly, decreasing the ACD. Corneal curvature and AL has no relation with age.

Key words: Presbyopia, central corneal thickness, anterior chamber depth, lens thickness, axial length

Introduction

Presbyopia is a condition in which a patient's amplitude of accommodation is decreased to the point where clear or comfortable vision at the desired near distance is not possible. It is an age-dependent loss of accommodative amplitude and afflicts the vast majority of individuals upon reaching middle age. Globally, the prevalence of presbyopia is expected to increase to one billion by the year 2020 (Ortner and Markovic, 2002). This increase is possibly due to increase in the life expectancy in most countries due to the availability of better healthcare system.

Presbyopia affects the quality of life. This seems straightforward in developed countries where reading and writing are the main near tasks performed. However, it is a misconception to assume that presbyopia has no impact on the quality of life in rural populations. Near vision is equally necessary for winnowing grain, weeding, sorting rice, cooking food, dressing children and adjusting

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lamps. Here we plan to study different anatomical parameters of the eye in presbyopic patients which may have a role in presbyopia.

Materials and methods

A prospective study was undertaken on 100 patients between 35-55 years of age presenting with difficulty in near vision or with non-specific complaints such as eyestrain and headache, after taking an informed consent. After general torch light examination, slit-lamp bio-microscopy and direct ophthalmoscopic fundus examination, all the patients underwent subjective refraction for best corrected visual acuity (BCVA) for distant and near. Those patients having BCVA 6/6 and near vision at least N8 and without any ocular pathology (normal anterior and posterior segments) or systemic illness were included in our study. The corneal radius of curvature (Horizontal K1and Vertical K2) was measured using a keratometer and approximating the horizontal and vertical mires. We used the DGH 5100e A-Scan/ Pachymeter to measure ACD, AXL, LT and CCT by applanation method (contact technique). The probe was gently placed on the centre of the cornea maintaining perpendicularity, with the patient in the supine position. It was ensured that no ointment or excess fluid was present on the cornea when commencing the applanation, since even a small amount of fluid may lead to an increased ACD reading. A drop of paracaine 0.5 % was instilled in the test eye to anaesthetize the cornea, followed by a drop of a lubricating agent. Patients were divided into two age groups: Group I (35 - 44 years) and Group II (45-55 years).

***Statistic*:** All statistical analysis was done using the software programme (SPSS, version 17.0) and using independent 't' test and paired 't' test.

Results

The total number of patients in Group I and Group II are 44 and 56 respectively. The mean and standard deviation of age Group-I was 41.14 ± 2.22 yrs and Group-II was 49.89 ± 3.09yrs.The mean and standard deviation of age in all 100 patients was 46.04 ± 5.15yrs. Total number of males and females in Group I were 23 and 21 respectively and that of those in Group II were 31 and 25 respectively. The decrease in central corneal thickness with increasing age was proved to be statistically significant ($p < 0.05$).

Table 1

Comparative analysis of central corneal thickness between age groups I and II

Variables	Age(yrs)	N	Mean ± SD	P-value
CCT RE	35-44	46	524.36 ± 28.52	< 0.05
	45-55	54	512.50 ± 20.69	
CCT LE	35-44	46	524.02 ± 26.30	< 0.05
	45-55	54	514.30 ± 18.66	

Table 2

Comparative analysis of anterior chamber depth between age groups I and II

Table 3

Comparative analysis of lens thickness between age groups I and II

Table 2 and 3 show that as age increased, the mean value of LT increased and ACD decreased in both eyes. These changes were statistically significant ($p < 0.05$) only in RE. When males and females were compared the LT and ACD changes were not statistically significant.

Nearly 3/4th of the total, the increase in LT was responsible for the decrease in ACD in RE and the rest 1/4th of increased lens thickness was towards the posterior segment (Table 4).

Table 4

Antero-posterior growth of lens in percentage

Lens growth	RE	LE
Anterior	73%	62%
Posterior	27%	38%

Axial length and corneal radius of curvature changes were not statistically significant ($p > 0.05$).

Discussion

The central part of the cornea is the thinnest part and thickness increases towards the periphery. Significant loss of endothelial cell occurs in advancing age. Duke Elder (1977) said that cornea becomes thinner as age changes. But another study (Lowe 1969 a, b, c) tells us that corneal thickness shows no significant change with age. In yet another study (Michiel Dubbelman et al 2001) it is stated that the central corneal thickness does not change significantly with age (mean thickness ± SD, 0.57±0.03mm). In our study, we observed that the mean of the central corneal thickness in both eyes decreased significantly with increasing age ($p < 0.05$).

With increasing age, the lens becomes larger and the centre of mass moves anteriorly. As a result, the anterior chamber becomes shallower by the same amount as the lens thickness increases (Jane et al 1997). Michiel Dubbelman et al (2001) showed that the anterior lens surface moved about 10 µm/ year toward the cornea, which resulted in a significant decrease in the anterior chamber depth.

Our study showed that as age increased the mean value of lens thickness increased and the anterior chamber depth decreased in both eyes. But these changes are proved to be statistically significant (p value < 0.05) only in RE. We also calculated that nearly 3/4th of total increase in lens thickness is responsible for the decrease in the anterior chamber depth and the rest 1/4th goes posteriorly. The above observation does not support Koretz et al (1989) and Jane et al (1997) who said that the centre of the mass of the lens is moved toward the cornea and that the retina remains unchanged throughout adult life. As a result, the anterior chamber becomes shallower by the same amount as the lens thickness increases. Michel Dubbelman et al (2001) said that the posterior lens surface recedes from the cornea with age, and that this backward movement does not differ significantly from the forward movement of the anterior lens surface.

So we can say that along with the theory of increasing equatorial diameter causing presbyopia (Schachar 1922), there is an antero-posterior growth of the lens with increasing age. But it is difficult to explain why the significant changes are found only in RE in our study. May be the changes (increase in LT and decrease in ACD) are asymmetrical and more in RE. But this has not been reported earlier in any study. So it may be an artifact as the sample size is small and perhaps requires another study with a bigger sample size. Lowe (1969 a, b, c) said that corneal thickness, corneal radius of curvature and AL showed no significant change with age so that the corneal surfaces and retina could be considered fixed reference points for measurement of lens changes. In our study also, the axial length didn't show any significant change with age.

Conclusion

Our study showed a decreasing CCT with advancing age thus highlighting the need of doing pachymetry before measuring the IOP because a decreased CCT might lead to a falsely low IOP resulting in glaucoma being possibly missed. Also, ACD decreased with age (asymmetrically) thus increasing the risk of angle closure glaucoma. An increasing lens thickness might be responsible for a decreasing accommodation and adding to the decreasing ACD. In BE, nearly 3/4th of the total increase in lens thickness happens anteriorly and is responsible for the decrease in the anterior chamber depth while the rest, 1/4th, of the increased LT goes posteriorly. Corneal radius of curvature and AL have no relation with advancing age.

References

Ortner C, Markovic O (2002). Causes and correction of presbyopia; A review Acta clin croat; 41 (suppl): 39-43.

Duke-Elder (1977). System of ophthalmology vol viii, p-867.

Jane F, Koretz, Cook C A, Kaufman P L 1997. Accommodation and Presbyopia in the human eye. IOVS, vol 38 no 3

Koretz JF, Kaufman PL, Neider MW, Goeckner PA (1989). Accommodation and presbyopia in the human eye: ageing of the anterior segment. Vision Res; 29 (12): 1685- 92.

Lowe RF (1964). Primary angle-closure glaucoma. Family histories and anterior chamber depth. Br J Ophthalmol; 48:191-195.

Lowe RF (1969). Causes of shallow anterior chamber in primary angle-closure glaucoma. Ultrasonic biometry of normal and angle-closure glaucoma eyes. Am J Ophthalmol; 67: 87-93.

Lowe RF (1972). Anterior lense curvature. Comparisions between normal eyes and those with primary angle-closure glaucoma; 56: 409-413.

Michel Dubbelman, Msc, G L Van Der Heijde, PhD, and Henk A (2001). Weeber, Msc. The thickness of the Aging human lens obtained from corrected scheimpflug images. Optometry vision science;78(6):411-416.

Schachar RA (1992). Cause and treatment of presbyopia with a method for increasing the amplitude of accommodation. Ann Ophthalmol; 24 (12): 445-52.

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