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Original Article

Ophthalmology Section

Changes in Lens Thickness and Amplitude of Accommodation with Age

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ABSTRACT

Introduction: The human crystalline lens is a transparent, biconvex structure in the eye that, along with the cornea, helps to refract light to be focused on the retina and, by changing shape, it adjusts focal distance and this function of the lens is called accommodation. Accommodation is the way, the eye increases optical power as it is necessary to produce a clear image of an object when it draws near the eye. Ageing reduces the ability of the lens to change shape, to adjust for close or distance vision.

Aim: To study the changes of lens thickness and Amplitude of Accommodation (AA) with age.

Materials and Methods: In this cross-sectional study, 40 healthy females were recruited from September to December 2018. The right eyes of 40 healthy participants were divided into two groups, the group 1 of 20 younger subjects (age range 18 to 28 years, mean age 21.9±2.73 years), and group 2 of middle-aged 20 subjects (age range 40 to 50 years, mean age 44.6±3.95 years). The lens thickness and AA was measured using A-scan ultrasonography and push-up method respectively. Statistical analysis was performed using SPSS, version 15 (SPSS Inc, Chicago, Illinois).

Results: The AA using push-up method in group 1 (11.28±1.44 D) was significantly higher than the AA in group 2 (4.49±1.01 D) and the mean difference was found 6.79 D. Unpaired t-test found $p<0.001$ and extremely significant. Lens thickness using A-scan ultrasonography was found in group 1 (3.74±0.13 mm) and in group 2 (4.10±0.31 mm) respectively. The mean difference between two groups was -0.36 mm and $p>0.05$ considered was non-significant.

Conclusion: The lens thickness increases with age but this increase was found statistically non-significant. The AA significantly decreased with increasing age.

Keywords: A-scan ultrasonography, Crystalline lens thickness, Push-up method

INTRODUCTION

The eye is a complex biological device; the healthy state of the eye alone does not always guarantee provision of clear and comfortable vision for an individual within a given distance. Accommodation is the process by which, the lens increases its refractive power so that the eye can focus on a near object of interest and it plays a significant role in the formation of clear retinal imagery [1,2]. Optometry uses psychophysical testing as an essential part of the examination procedure. Psychophysics, determine whether a subject can detect a stimulus, differentiate between stimulus, and describe the magnitude or nature of this difference [3]. In accommodative amplitude testing using push-up method, the method of limits psychophysical testing procedure is used. The loss of accommodative ability with age is due to an increase in lens size and shape, a reduction in the elasticity of the lens capsule and a loss in the elasticity of the lens fibers. These physiological changes begin at age 16 and continue to age 60-65 [4-6]. The purpose of this study was to determine the AA and lens thickness with age in King Saud University (KSU) females and to compare the results with the previous reported work.

The human crystalline lens continues to create new cells and grow throughout life. There are experimental evidences in the literature showing that age-related changes occur in the crystalline lens and these changes are more noticeable in the middle age [7-13].

The accurate measurement of lens thickness is very important for biometric studies of myopia and Primary Angle-Closure Glaucoma (PACG) [13-15]. Thickening and anterior positioning of the lens is recognised as a major anatomic predisposing factor for the development of angle closure [7,16,17]. Lens thickness measurements can be done using A-scan ultrasonography (A-scan US) and Scheimpflug photography. A-scan ultrasonography is the gold standard for both clinical practice and research to measure the thickness of the crystalline lens [18].

The purpose of this study was to determine the AA and lens thickness with age among females of King Saud University, Riyadh, Saudi Arabia.

MATERIALS AND METHODS

This cross-sectional study included healthy right eye only of 40 Saudi female subjects of two age groups, group 1 with ages between 18 to 28 years; and group 2 with ages between 40 to 50 years. These subjects were students and university workers, recruited using e-mail announcements and data was collected for the right eye (with the left eye occluded) in four months from September to December 2018 in the optometry Clinic at College of Applied Medical Science, King Saud University, Riyadh. Ethical approval (Ethics Number: CAMS 09-37/38) was obtained from the Research Ethics Committee at King Saud University.

Subjective AA was measured using the push-up to blur technique and a small letter target. The crystalline lens thickness was measured by A-scan ultrasound.

Exclusion criteria were systemic diseases with ocular complications, cataract patients, post-surgery patients and patients with binocularity problems. After the purpose and procedures used in the study were fully explained, each participant gave their written informed consent.

After taking medical and family history, all subjects underwent full ophthalmological examination in the form of the visual acuity test using tumbling E-test, refraction to correct visual acuity, slit lamp examination of the crystalline lens, and examination of binocular vision. The measurements were performed independently by two experienced operators. The operators were masked to one another's results and mean AA was calculated. The measurements were performed without pupil dilation in the same room in standard illumination conditions.

Subjects with refractive errors wore their habitual corrections for this study measurement. Instructions were given to the subject to read the letters clearly on the chart, it being moved slowly closer to the subject until the subject indicated blur. The distance from the chart to the patient's spectacle plane in centimeters was measured (the near point of accommodation). This linear distance is converted into diopters by dividing the near point of accommodation in centimeters into 100. The resulting dioptral value represents the patient's AA. This was performed twice on each patient, and an average was calculated. AA for all the subjects were measured as a function of age, and the curvilinear regression analysis were used to describe the change in accommodative amplitude with increasing age.

Before the measurement of lens thickness using A-scan ultrasonography, this test was described briefly to the participant. The probe was cleaned properly by alcohol swab and the topical anesthesia was administered. The ultrasound probe was placed perpendicularly at the center of the cornea without applying any pressure on the eye. The subject was asked to fixate on the internal fixation red light. When the ultrasound probe touched the cornea, the probe tip sends one thin, parallel sound beam at frequency of 8 MHz, the echoes received back into the probe from each of interfaces and they are converted by the biometer to spikes arising from the baseline. Before accepting the scan, the quality of the scan chart was checked.

STATISTICAL ANALYSIS

All data were analysed using SPSS, version 15 (SPSS Inc, Chicago, Illinois) statistical software. Mean and standard deviations were calculated. Spearman correlation coefficients and linear regression were also used. The values of lens thickness and the AA with age, between the two groups were compared by using unpaired t-testing.

RESULTS

All the 40 subjects were divided into two groups of 20 subjects. The mean age±Standard Deviation (SD) of group 1 was 21.9±2.73 years (range 18 to 28 years) and the mean age of group 2 was 44.6±3.95 years (range 40 to 50 years).

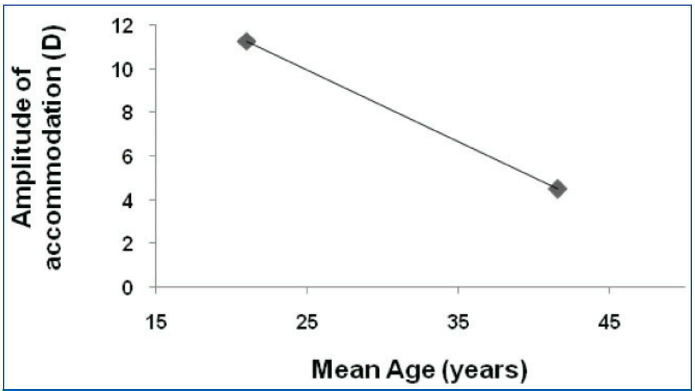
The mean of AA in group 1 was found 11.28±1.44 D and in group 2 was 4.49±1.01 D, respectively. The mean difference of AA was 6.79 D in both groups. In group 1, the mean of AA was found significantly higher than in group 2. Unpaired t-test p-value <0.001 considered extremely significant. The AA in group 1 of non-presbyopic subjects was found good and negatively correlated (r=-0.44) with age. The p-value was found 0.04 and extremely significant. In group 2 of presbyopic subjects the value of coefficient of correlation was r=-0.63 and p=0.002.

In group 1 and group 2 the average of the lens thickness using A-scan ultrasonography was found 3.74±0.13 mm and 4.10±0.31 mm respectively. The mean difference was -0.36 mm. Unpaired t-test p>.05 considered non-significant.

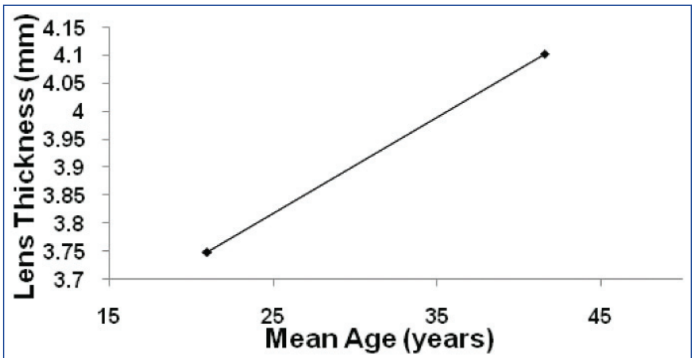
Correlation between age and lens thickness in group 1 was found weak and negative (r=-0.36) and p-value statistically non-significant (p=0.11). Correlation between age and lens thickness in group 2 was found again weak and negative (r=-0.02) and p-value statistically non-significant (p=0.90).

Average values of AA in group 1 and group 2 as a function of age are shown in [Table/Fig-1].

Average of lens thickness as a function of age in both groups is presented in [Table/Fig-2].



[Table/Fig-1]: Average of amplitude of accommodation as a function of age in the two groups.



[Table/Fig-2]: Average of the lens thickness as a function of age in the two groups.

DISCUSSION

This study found changes in AA extremely significant with age (p<0.001). Iyamu E et al., studied 83 subjects of age range 17-30 years and found similar AA of present study, because the age range of present study subject's was 18-28 years. He also found inverse correlation between age and AA and observed these changes statistically significant with age (p<0.001) [1].

Kenneth K et al., and Marc BT and Shallo-Hoffmann J, found the average value of AA using push-up method 11.1±2.68 D in 25 subjects of age range 21-35 years and 11.00±3.20 D in 30 subjects of age range 21-36 years, respectively [2,19].

Solani DM et al., found average AA in South African university students 10.23±1.67 D in 45 subjects of age range 21-27 years [20]. In South African university students, the average value of AA was found minimum as compared to other studies for the same age range.

Another study done by Hamed MM et al., for AA using push-up method in 52 subjects, age range 18-25 years, and found almost same value as in the present study [21]. The present results of AA are consistent with those of previous work that has used push-up method in which object size was adjusted for viewing distance. The difference was only in age, in the present study subjects were 18 to 50 years old, while in the other studies, subjects were 17 to 39 years old. AA data of previous reported and the index study is shown in [Table/Fig-3] [1,2,19-21].

Crystalline lens thickness increases with age in this study but changes in lens thickness were not found significant with age (p>0.05). Jorge LA et al., found changes in lens thickness statistically significant with age (p<0.001) [18]. This study included 72 eyes of 72 subjects of ages 8-80 years (mean age 41±21 years); and that was the reason of disagreement with this study. An explanation for this larger than previously reported difference is most likely related to the age of the subjects studied.

LIMITATION

Only normal and healthy subjects were included in the study. Symptomatic subjects did not participate in the study, and it is possible that the results from such a group would have been different.

Author	No. of subjects	Age range (years)	AA by Push-up method
Iyamu E et al., [1]	83	17-30	11.28±2.12 D
	37	40-39	5.78±1.33 D
Kenneth K et al., [2]	25	21-35	11.1±2.68 D
Marc BT and Shallo-Hoffmann J [19]	30	21-36	11.00±3.20 D
Solani D et al., [20]	45	21-27	10.23±1.67 D
Hamed MM et al., [21]	52	18-25	11.21±1.85 D
Present study	20	18-28	11.28±1.44 D
	20	40-50	4.49±1.01 D

[Table/Fig-3]: The amplitude of accommodation data of previous reported studies and data of present study [1,2,19-21].

CONCLUSION

The crystalline lens thickness measurement made by A-scan ultrasonography found increase in lens thickness with age but this change was statistically insignificant. The AA using push-up method found significant decrease with increasing age.

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