ORIGINAL ARTICLE

Sonographic Evaluation of Lens Thickness in Non – Diabetics and Diabetics with High-Resolution Ultrasound in a Tertiary Care Hospital

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Abstract:

Background: Adult lenses have a thickness of approximately 4.0–5.0 mm and an average annual growth of 0.023 mm. It has been discovered that the human lens' thickness varies with age, sex, cataract type, and diabetes status**.** Myopia, presbyopia, and angle-closure glaucoma, among other disorders, are significantly influenced by the thickness of the crystalline lens. So, this study was undertaken to determine the lens thickness of diabetic individuals with a comparison of a control group. *Material and Methods:* An observational study with a control group was done at the Department of Radiology, to measure central lens thickness using High-resolution ultrasound of both eyes among Diabetic patients. They were compared to age, gender-matched healthy controls. The data were interpreted using MS Excel and SPSS software version 21. *Results:* The mean central lens thickness was 3.759±0.294 mm among Diabetic individuals and 3.275±0.266 mm among non-diabetic individuals in the right eye. The mean central lens thickness was 3.746±0.432 mm among Diabetic individuals and 3.159±0.232mm among non-diabetic individuals in the left eye. Diabetic individuals had significantly thicker lenses on both sides compared with healthy individuals. Age is also a significant factor, which shows a positive correlation. *Conclusion:* The sonographer evaluation reveals the central lens thickness was increased among Diabetic eyes compared with non-diabetic eyes.

Keywords: Ultrasound, Lens thickness, Glaucoma, Diabetes, Cataract, Refraction

Introduction:

The human optical lens includes of a lens capsule, epithelial cells, lens fibres and zonules. Adult lenses have a diameter of approximately 9.0–10.0 mm, a thickness of approximately 4.0–5.0 mm, and an average annual growth of 0.023 mm.[1]The lens geometry of Asian eyes can differ from Caucasian eyes due to the increased prevalence of myopia and extreme myopia in Asia.[2]Throughout life, the individual's crystalline lens tends to develop and produce new cells.The average human lens was 4 mm thick at age 20, 4.3 mm thick at age 40, 4.45 mm thick at age 50, 4.7 mm thick at age 60, and increased in thickness to beyond 4.7 mm after age 60.[3] It has been discovered that the human lens' thickness varies with age, sex, cataract type, and presence of Diabetes**.**[3]Myopia, presbyopia, and angle-closure glaucoma, among other disorders, are significantly influenced by the thickness of the crystalline lens.[4]

The number of people having diabetes mellitus (DM) globally was anticipated by the International Diabetes Federation (IDF) to be 463 million in 2019 and to reach 700 million by 2045.[5]Diabetic retinopathy and papillopathy, cataract, glaucoma, and ocular surface disorders are the principal visual problems related to DM.[6]Diabetic retinopathy (DR), the most prevalent and distinct complication of DM, is a major risk factorfor avoidable blindness in the adult working population.[5]DR affects one-third of diabetes individuals.[7]In 2020, there were thought to be 103.12 million adults worldwide who had DR; by 2045, that number is expected to increase to 160.50 million.[5]Diabetes can alter the lens in the following ways: Lens changes, refractive change, light scattering, chromophore accumulation, fluorescence, cataract and capsular changes. [8]

The lens thickens with age, according to numerous investigations using ultrasound, Scheimpflug photography, partial coherence interferometry (PCI), and magnetic resonance imaging (MRI).[9]

It has been established that USG's ocular biometry is more accurate and trustworthy than optical measurement.[10]Even in the presence of intervening optically opaque materials, ultrasound offers very cost-effective real-time cross-sectional images. In the 1950s, Mundt and Hughes (A-scan) and Baum and Greenwood (B-scan) developed the first ultrasound systems for use in diagnostic imaging of the eye.[11]The standard technique for determining the biometric measurements of lens thickness is A-scan ultrasonography (A-scan US).[4]On the B-scan, the posterior portion displays normal, clear vitreous, and the anterior segment reveals the echo of the posterior lens capsule.[12]

In comparison to traditional ophthalmic B-scanners, ultrasound biomicroscopy (UBM) employs frequencies that are substantially higher (35-50 MHz). As a result, ultrasound gets one step closer to fulfilling the requirements for the ideal imaging instrument, increasing resolution to 40 mm or less. The cornea, iridocorneal angle, anterior chamber, iris, ciliary body, and lens are imaged with ultrasound biomicroscopy equipment, along with nearly all anterior segment anatomy and disease. In most cases, the crystalline lens produces specular surface reflectivity with little interior echoes.[11]

Environmental variables and medical disorders can also affect refraction. As a result, diabetes mellitus may alter refraction both temporarily and permanently. It is widely believed that short-term fluctuations affect the lens' refraction mostly through changes in osmotic pressure brought on by variations in blood glucose levels.[13]The diabetes status also contributes to increasing lens thickness which affects vision. So, this study is an attempt to determine central lens thickness in diabetes compared with controls. The objectives of the study are to compare the central lens thickness of diabetic &non-diabetic patients (of similar age, and gender) using High Resolution Ultrasound and to compare the variation in central lens thickness between both eyes of diabetic patients.

Material and Methods:

An observational study was done at Department of Radiology, Trichy SRM Medical College Hospital and Research Centre, Trichy for six months (July 2023 – January2024) duration to determine the central lens thickness using high resolution ultrasound among patients with and without diabetes. Patients aged forty and years above referred for High-Resolution Ultrasound to the Department of Radiology, Trichy SRM Medical College Hospital and Research Centre, Trichy were selected as Participants. Patients who had already undergone

intraocular surgery/diagnosed with any corneal pathology, patients with inflammatory conditions like conjunctivitis, uveitis, scleritis, patients with associated hypertension and other co-morbidities, patients on statin medication and the participants not willing to give consent were excluded from study. The cases (patients with diabetes) and controls (patient without diabetes) were selected using non probability sampling method. Based on inclusion and exclusion criteria eight-five cases and eighty-five controls were included in the study. Data was gathered in the Department of Radiology using semi-structured questionnaire among participants by interview method after getting their consent. Voluson S8, E6 machine with a multi-frequency linear transducer of 7.5 MHz was used for this study. Patients were placed in the supine posture for the B-Mode ultrasonography examination. Patients were scanned with their eyes closed while a minimum quantity of sonographic gel was applied to the probe. In the transverse projection, the probe was gently placed on the eyelid. Zooming in to fill the screen and reducing depth to include the back of the lens. The screen's centre was maintained for the lens. Midway between the front and posterior capsules of the lens, the maximum thickness of the lens was measured.Data was entered in Microsoft Excel 2019 and analysed using the software SPSS (Statistical Package of Social Sciences) version 21. The data were interpreted using frequencies (mean±SD) for quantitative variables and proportions (%) for qualitative variables. The independent T-test was utilised to test the association of central lens thickness among study and control groups. Approval was taken from theInstitutional Ethical Committee of the hospital. Participants were informed about the study and their informed consent was obtained.

Results:

This study was aimed to compare the central lens thickness of eight five diabetic and non-diabetic individuals to determine their central lens thickness. Table 1 describes the age group, gender and family history of diabetes of individuals. 15.3%, 32.9% and 51.8% of the diabetic individuals belonged to the age group of 41 – 50 years, 51 – 60 years and 61 – 80 years respectively. 31.8%, 38.8% and 29% of the non-diabetic individuals belonged to the age group of 41 – 50 years, 51 – 60 years, and 61 – 80 years respectively. Nearly half of the individuals who participated in this study from both groups were males. 42.4% of diabetic individuals had a family history of diabetes.

Table 1: Descriptive data of participants

Sr. No	Variables		Diabetes (n = 85)	Non-Diabetes (n = 85)
1	Age group	41–50 years	13 (15.3%)	27 (31.8%)
		51–60 years	28 (32.9%)	33 (38.8%)
2	Gender	Male	48 (56.5%)	49 (57.6%)
		Female	37 (43.5%)	36 (42.4%)
3	Family History of Diabetes	Present	36 (42.4%)	0
		Absent	49 (57.6%)	100 (100%)

Table 2 describes the association between demographic variables and diabetic status. Diabetes was more common in the age group 61 – 80 years. Diabetes was more common among individuals with a family history of diabetes. The mean age of participants was 64.047±9.71 years in diabetic group and 56.65±9.35 years in non-diabetic group.

Table 2: Association between demographic variables and diabetic status

Sr. No	Variables		Diabetes (n = 85)	Non-Diabetes (n = 85)	p-value
1	Age group	41 – 50 years	13 (32.5%)	27 (67.5%)	0.001
		51 – 60 years	18 (35.3%)	33 (64.7%)	
		61 – 70 years	25 (59.5%)	17 (40.5%)	
		71 – 80 years	29 (78.4%)	8 (21.6%)	
2	Gender	Male	48 (49.5%)	49 (50.5%)	0.877
		Female	37 (50.7%)	36 (49.3%)	
3	Family History of Diabetes	Present	36 (100%)	0	0.001
		Absent	49 (36.6%)	85 (63.4%)	

Table 3 shows central lens thickness among individuals. The mean central lens thickness was found to be higher in diabetic individuals compared with non-diabetic individuals and this seems to be statistically significant. The mean central lens thickness was 3.759±0.294 mm (ranging from 3 – 4.3mm) among diabetic individuals and 3.275±0.266 mm (ranging from 3 – 4 mm) among non-diabetic individuals in the right eye. The mean central lens thickness was 3.746±0.432 mm among diabetic individuals and 3.159±0.232 mm among non-diabetic individuals in the left eye.

Table 3: Central Lens thickness among individuals (in mm)

Sr. No	Variable	Diabetes	Non-Diabetes	p-value
1	Right	3.759±0.294	3.275±0.266	0.001
2	Left	3.746±0.432	3.159±0.232	0.001

The mean central lens thickness was 3.759 mm and 3.746±0.432 mm in the right eye and left eye of diabetes patients respectively where there was no significant difference in the right and left eye (p = 0.820).

Table 4 shows the correlation of age with central lens thickness. Age shows a positive correlation (r = 0.537) in the right eye and the left eye (r = 0.517) with a statistically significant p-value (p-value = 0.001). Therefore, it is seen that the central lens thickness increases with respect to age. Age showed a positive correlation with central lens thickness and was found to be statistically significant.

Table 4: Correlation of age with central lens thickness

S No	Variable	Diabetes	Non-Diabetes
1	Right	r = 0.537 p = <0.001	r = 0.585 p = <0.001
2	Left	r = 0.442 p = <0.001	r = 0.522 p = <0.001

Table 5 shows the association of central lens thickness with gender variables.There was no significant change in the central lens thickness of both eyes among male and female individuals.

Table 5: Association of central lens thickness with gender variable (in mm)

Sr No	Group	Varia-ble	Male	Female	p-value
1	Diabetes	Right	3.783±0.250	3.727±0.343	0.385
		Left	3.792±0.501	3.686±0.320	0.269
2	Non-Diabetes	Right	3.294±0.305	3.25±0.204	0.457
		Left	3.171±0.27	3.142±0.169	0.562

Discussion:

The mean central lens thickness of the right eye was 3.759±0.294 mm among Diabetic and 3.275±0.266 mm among non-diabetic. The mean central lens thickness of the left eye was 3.746±0.432mmamong diabetic and 3.159±0.232 mm among non-diabetic.

Deepa KB et al[14] in a study found that lens thickness of the right eye was 4.1±2.9 mm among diabetic retinopathy patients, while it was 3.7±1.3 mm among normal healthy individuals, and the difference among groups was found to be statistically significant. The difference in lens thickness of the left eye was found to be statistically significant among DR cases (4.2±0.3 mm) and normal controls (3.7±0.1 mm). According to Shrestha S et al[15] in Nepal, diabetic participants' crystalline lenses(4.33±0.38mm) were substantially thicker than those of the control group(4.05±0.55mm).Studies found that diabetes contributes to lens thickness significantly, which was similar to our study results.

Thomas et al[16] among the Nigerian population found that Diabetes (3.76±0.45 mm) had thicker lenses compared to non diabetes (3.56±0.34 mm). Ye L et al(17) among Chinese adults aged fifty and above found that Lens thickness among Diabetics (4.63±0.32 mm) was significantly different compared to the control group (4.69±0.36 mm).

Thomas et al[16], Meng et al[2], Sharma et al[18], and Praveen MR et al[3]found that increasing lens thickness due to increasing age seems to be a positive correlation between age and lens thickness. Praveen MR et al[3] concluded that with each decade of age advancement, lens thickness was increased by 0.155 mm. Pierro L et al[19] found that there was significant changes in lens thickness among Diabetes compared with Non Diabetes among patients with no and proliferative retinopathy and also the author stated that lens thickness had significant correlation with duration of diabetes.

Diabetics have thicker lenses than healthy patients, primarily because of cortical thickening. The lens's front and rear curvatures getting steeper, and the anterior chamber getting shallower, are other biometric alterations. After correcting for age, insulin-dependent (type 1) diabetics exhibit the most substantial alterations, and the duration of diabetes has a significant independent impact on lens thickness. This rise among type 1 diabetics does appear to be influenced by the prevalence of diabetic retinopathy.[8] Although this study does not stratify type of diabetes, lens thickness has significantly increased among diabetic individuals.

Conclusion:

The diabetic lens is larger than average, more susceptible to refractive alteration, and more likely to develop a cataract, sometimes of a particular variety. As a result, reliable lens thickness measurements are crucial for research on the onset of refractive error, cataract surgery, and angle closure glaucoma.Therefore, regular ocular follow-up with high-resolution ultrasound is necessary to aid in the early diagnosis of lenticular thickness changes that may increase the risk of cataract formation, and reduce vision, and glaucomatous changes that may have preventive implications.

Limitations:

The sample size was small for generalizing the results**.** The variables like associated co-morbid conditions, duration of diabetes, and type of diabetes were not included.

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Conflicts of interest: Nil

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