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The Influence of Diabetes Mellitus on Lenticular Thickness

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Abstract The prevalence of diabetes is increasing exponentially often causing an enormous public health burden. A hospital based observational study was undertaken and 144 type I diabetic subjects with equal number of non-diabetic controls were enrolled. The mean lens thickness, duration, fasting blood sugar, post prandial blood sugar and glycated hemoglobin were assessed. The crystalline lens was thicker in the diabetic group (4.33±0.38 mm *vs* 4.05±0.55 mm) which was statistically significant ($p<0.001$). There was a significant correlation between lens thickness and age ($p<0.001$, $r=0.651$) and between lens thickness and duration of diabetes ($p<0.001$, $r=0.468$). However, HBA1c and blood sugar levels had no significant influence on lenticular thickness.

Keywords: *lens thickness, diabetes, duration, blood sugar level*

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1. Introduction

The prevalence of diabetes has increased exponentially reaching epidemic proportions worldwide. This is probably due to changing lifestyle as there is increasing obesity and reduced activity levels. The total number of people with diabetes is expected to rise from 171 million in 2000 to 366 million in 2030 [1].

Diabetes may cause fluctuation in the refractive state of the eye. Both myopic shifts [2,3] and hyperopic shifts [4,5] have been reported in diabetic patients. Some studies also reported that there was no influence of diabetes mellitus on ocular refraction [6,7].

The crystalline lens is a major determinant of refraction. Human crystalline lens becomes thicker with increasing age, as the lens fibers are continually added over time [8]. The sagittal width of the lens is about 4 mm at birth. It remains so for the first 20 years as it expands equatorially [9]. After second decade of life, lens thickness increases continuously by about 0.15-0.2 mm per decade [10]. Generally, the refractive power increases with a more convex shape of the refractive surface. One would expect a myopic shift with the increase in the refractive power of the eye. However, with the increasing age, there is tendency towards hyperopia [11,12]. This paradoxical phenomenon in which the increase in convexity of the lens with age, not being associated with myopic shift in ocular refractive error, has been called the "lens paradox". This can be justified by a decrease in the equivalent refractive index of the lens with age, which compensates for the more convex shape of the aging lens and thereby preventing the myopic shift [13]. Lenticular thickness is affected by age, sex, cataract and diabetic status [14].

The crystalline lens in a diabetic patient undergoes changes in the shape as a result of osmotic changes. The alteration in the lenticular thickness especially in early onset diabetes may be due to over-hydration or they may be in a state of accelerated growth with either more (hyperplastic mechanism) secondary lens fibers or larger secondary lens fibers (hypertrophic mechanism) being formed [15]. Since the lens thickness increases with age, it is difficult to separate the effect of diabetes duration from the effect of increasing age [16].

This study was undertaken to measure the lens thickness in patients with type I diabetes and the influence of blood sugar level and the duration of diabetes mellitus in the lens thickness.

2. Materials and methods

A hospital-based observational study was carried out in the Department of Ophthalmology, Manipal Teaching Hospital, Pokhara from October 2013 to March 2015. The total sample size was one hundred and forty-four type I diabetic subjects which was calculated considering type one error of 0.05 and power of 80% with enrollment of equal number of controls. Diabetic patients with normal anterior segment and patients with good vision for the eye to hold fixation during A-scan were included in the study. Diabetic patients with cataract, glaucoma, prior surgical history or prior history of trauma were excluded from the study. Any cataract was defined as the presence of nuclear cataract (LOCS III Score for nuclear opalescence of ≥3), any cortical cataract (LOCS III Score ≥2), or any posterior subcapsular cataract (LOCS III Score of ≥2). Glycemic control was categorized as normal (HBA1c <5.6%), good (5.6-7.0%), fair (7.1-8.0%), unsatisfactory (8.1-10.0%) or poor (>10.0%). All the patients had undergone complete ophthalmologic examination including visual acuity, refraction and slit-lamp examination. Lens thickness was measured using AB mode Ultrasound (Sonomed E-Z Scan AB5500). Preceding the study, ethical approval from the institutional research ethical committee was taken. Informed consent was taken in all the patients involved in the study and confidentiality was maintained. Data were collected and analyzed using statistical software SPSS version 21. Preliminary analysis was carried out and the results were presented as mean in both the groups. Independent sample t-test was applied to determine the difference between two independent means. Correlation between two variable was established by using Pearson correlation factor. A *‘p’* value less than 0.05 was considered as statistically significant and 95% CI was used as a measure of precision.

3. Results

288 eyes of 144 diabetic subjects were analyzed. Table 1 lists the baseline characteristics of both the diabetic and control group. The mean age in diabetic group was 49.42±10.93 years (range: 20-81 years) whereas it was 46.12±11.82 years (range: 20-71 years) in control group. Diabetic subjects had significantly thicker crystalline lenses as compared to the control (4.33±0.38 mm versus 4.05±0.55 mm, $p<0.001$, Table 1). The lens thickness ranged from 3.28-5.54 mm in the diabetic group.

Table 1. Baseline Characteristics of Diabetic and Control Group

	Diabetic Group	Control Group
No. of eyes/ patients	288/144	288/144
Age (years) (Mean±SD)	49.42±10.93	46.12±11.82
Gender (Male/Female)	81/63	50/94
Mean lens thickness (mm)	4.33±0.38	4.05±0.55
Mean duration (years)	5.73±4.69	-
Mean fasting blood sugar (mg/dl)	145.14±62.45	-
Mean post-prandial blood sugar (mg/dl)	218.0±86.22	-
Mean glycated hemoglobin (%)	7.05±0.94	-

Table 2 demonstrates the level of glycemic control in the diabetic patients. Majority (45.8%) of the patients had good glycemic control (HBA1c: 5.6-7.0%).

Table 2. Distribution of Glycemic Control

Glycemic Control	Glycated Hemoglobin (%)	Frequency	Percentage
Normal	<5.6	5	3.5
Good	5.6-7.0	66	45.8
Fair	7.1-8.0	50	34.7
Unsatisfactory	8.1-10.0	22	15.3
Poor	>10.0	1	0.7

The lens thickness showed an increasing trend with increasing age which was found to be significant (Figure 1) ($p<0.001$, $r=0.651$).

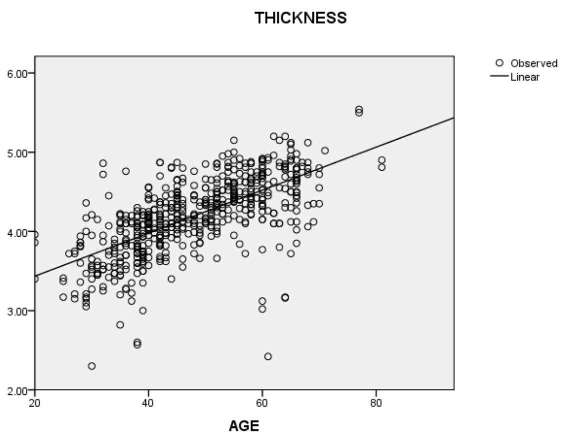

Figure 1. Correlation between lens thickness and age

Figure 2 shows the correlation between lens thickness and duration of diabetes ($p<0.001$, $r=0.468$). However, fasting blood sugar, post-prandial blood sugar and glycated hemoglobin showed no effect on the thickness of the lens. Figure 3 shows a constant correlation between lens thickness and glycated hemoglobin.

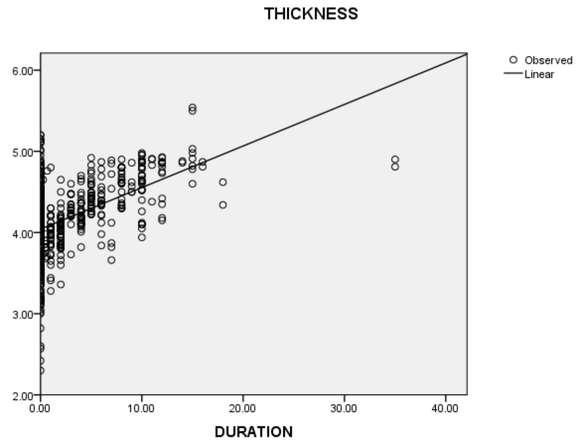

Figure 2. Correlation between lens thickness and duration

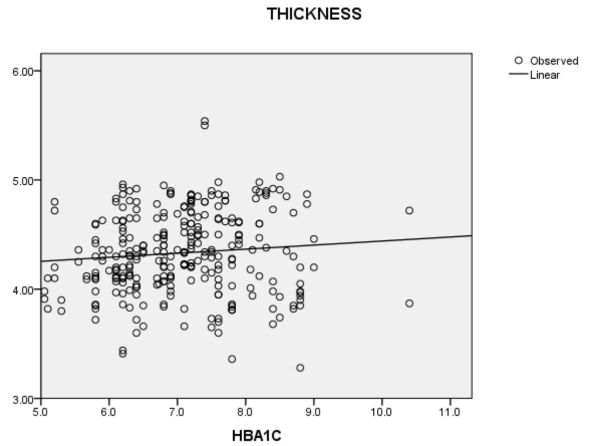

Figure 3. Correlation between lens thickness and glycated hemoglobin

4. Discussions

The crystalline lens accounts for 20% of the total eye's refractive power. Any change in the morphology of the crystalline lens in patients with diabetes mellitus is associated with the alteration in the refractive status. The results of this study have highlighted the impact of type I diabetes mellitus on the lenticular thickness. Comparing the non-cataractous diabetic subjects with the non-diabetic controls revealed a profound impact of diabetes on the thickness of the crystalline lens.

The mean lens thickness in our diabetic population was 4.33±0.38 mm which was similar to the study conducted in Chinese population where the lens thickness 4.34±0.15 mm [17]. Similarly, the mean value of lens thickness in a study by Fledelius *et al* was 4.74 mm. This increase in the thickness probably might be because of the overall increased duration of diabetes as compared to our population (13.3 years *vs* 5.7 years) [18]. Pierro *et al* divided the insulin dependent diabetes mellitus patients into 3 categories; the lens thickness in patients without diabetic retinopathy was 3.81±0.57 mm, those with background retinopathy was 3.90±0.57 mm and with proliferative retinopathy was 4.25±0.45 mm [19].

This study agrees with the results of earlier studies which have reported a positive association between the presence of type I diabetes and increase in lens thickness [16,18-24]. The increase in the lens thickness in diabetic patients is probably either because of over-hydration or increased growth of the individual lens fibers [23]. During the periods of hyperglycemia, there is accumulation of glucose in the lens which gets converted to sorbitol which is further converted into fructose. These sugar alcohols tend to accumulate within the lens fibers, as they are poorly permeable through the lens membrane. This creates an osmotic gradient resulting in the influx of water into the lens producing marked lenticular swelling.

There was a marked effect of diabetic duration on lens thickness of type I diabetic subjects which was identical to the previous reports [18,19,23,24]. Løgstrup *et al* demonstrated a higher correlation between duration of insulin dependent diabetes mellitus and lens thickness in monozygotic twins as compared with dizygotic twins [16]. Most of the studies did not find any significant change in the internal structure and overall lens thickness in patients with type II diabetes. Also, there was no significant association between the duration of diabetes and lens thickness in type II diabetic patients [15,22,23].

There was no substantial association between the metabolic control of diabetes mellitus and the thickness of the lens. This result was congruent with other reports which showed no significant impact of blood glucose level on the various lens parameters [19,22,23].

5. Conclusion

The results of the present study showed that diabetes mellitus type I had a profound effect in the lens thickness. The duration of diabetes was also an important parameter which is responsible for the increase in lens thickness. However, HBA1c and blood sugar levels (Fasting blood sugar and post prandial blood sugar) had no significant influence on lenticular thickness.

6. Limitations

As only type I diabetic subjects were taken as cases, we could not generalize our findings to both the type of diabetes. Both the types of diabetes could have been taken to compare their effects on lens thickness. As the patients with proliferative diabetic retinopathy were very few, the effect of diabetic retinopathy on the lenticular thickness could not be assessed as in some other studies.

Declaration of Conflicting Interests

The authors declare that there is no potential conflicts of interest with respect to the research, authorship and /or publication of this article.

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References

[1] Wild S, Reglic G, Green A, Sicree R, King H. Global Prevalence of Diabetes. *Diabetes Care*. 2004; 27: 1047–1053.

[2] Duke Elder S. Changes in refraction in diabetes mellitus. *Br J Ophthalmol*. 1925; 9: 167-187.

[3] Fledelius HC, Fuchs J, Reck A. Refraction in diabetics during metabolic dysregulation, acute or chronic. With special reference to the diabetic myopia concept. *Acta Ophthalmol (Copenh)*. 1990; 68 (3): 275-280.

[4] Eva PR, Pascoe PT, Vaughan DG. Refractive changes in hyperglycemia: Hyperopia, not myopia. *Acta Ophthalmol*. 1982; 66: 500-505.

[5] Giusti C. Transient hyperopic refractive changes in newly diagnosed juvenile diabetes. *Swiss Med Wkly*. 2003; 133 (13-14): 200-205.

[6] Guzowski M, Wang JJ, Rochtchina E, Rose K, Mitchell P. Five-year refractive changes in an older population: the Blue Mountains Eye Study. *Ophthalmology*. 2003; 110: 1364-70.

[7] Shimizu N, Nomura H, Ando F, Niino N, Miyake Y, Shimokata H. Refractive errors and factors associated with myopia in an adult Japanese population. *Jpn J Ophthalmol*. 2003; 47: 6-12.

[8] Hoffer KJ. Axial dimension of the human cataractous lens. *Arch Ophthalmol*. 1993; 111: 914-918.

[9] Bron AJ, Sparrow J, Brown NAP, Harding JJ, Blankytny R. The lens in diabetes. *Eye*. 1993; 7: 260-275.

[10] Roters S, Hellmich M, Szurman P. Prediction of axial length on the basis of vitreous body length and lens thickness. Retrospective echobiometric study. *J Cataract Refract Surg*. 2002; 28: 853-859.

[11] Saunders H. A longitudinal study of the age-dependence of human ocular refraction I. Age-dependent changes in the equivalent sphere. *Ophthalmic Physiol Opt*. 1986; 6: 39-46.

[12] Slataper FJ. Age norms of refraction and vision. *Arch Ophthalmol*. 1950; 43: 466-481.

[13] Moffat BA, Atchison DA, Pope JM. Explanation of the lens paradox. *Optom Vis Sci*. 2002; 79: 148-50.

[14] Koretz JF, Kaufman PL, Neider MW, Goeckner PA. Accommodation and presbyopia in the human eye aging of the anterior segment. *Vis Res*. 1989; 29: 1685-1692.

[15] Sparrow JM, Bron AJ, Brown NA, Neil HA. Biometry of crystalline lens in late onset diabetes: the importance of diabetic type. *Br J Ophthalmology*. 1992; 76: 428-433.

[16] Logstrup N, Sjolie AK, Kyvik KO, Green A. Lens thickness and insulin dependent diabetes mellitus: a population based twin study. *Br J Ophthalmol*. 1996; 80: 405-408.

[17] Li HY, Luo GC, Guo J, Liang Z. Effects of glycemic control on refraction in diabetic patients. *Int J Ophthalmol*. 2010; 3 (2): 158-160.

[18] Fledelius HC, Miyamoto K. Diabetic myopia- is it lens induced? An oculometric study comprising ultrasound measurements. *Acta Ophthalmologica*. 1987; 65: 469-473.

[19] Pierro L, Brancato R, Zaganelli E, Guarisco L, Calori G. Correlation of lens thickness with blood glucose control in diabetes mellitus. *Acta Ophthalmologica Scandinavica*. 1996; 74: 539-541.

[20] Adnan, Pope JM, Sepehrband F, Suheimat M, Verkicharla PK, Kasthurirangan S, *et al*. Lens Shape and Refractive Index Distribution in Type I Diabetes. *Invest Ophthalmol Vis Sci*. 2015; 56(8): 4759-66.

[21] SaitoY, Ohmi G, Kinoshita S, Nakamura Y, Ogawa K, Harino S, *et al*. Transient hyperopia with lens swelling at initial therapy in diabetes. *British J Ophthalmology*. 1993; 77: 145-148.

[22] Weimer NGM, Dubbelman M, Kostense PJ, Ringens PJ, Polak BCP. The influence of DM Type 1 and 2 on the Thickness, Shape, and Equivalent Refractive Index of the Human Crystalline Lens. *Ophthalmology*. 2008; 115 (10): 1679-86.

[23] Weimer NGM, Dubbelman M, Hermans EA, Ringens PJ, Polak BCP. Changes in the Internal Structure of the Human Crystalline Lens with Diabetes Mellitus Type 1 and Type 2. *Ophthalmology*. 2008; 115 (11): 2017-23.

[24] Sparrow JM, Bron AJ, Brown AP, Neil HAW. Biometry of crystalline lens in early onset diabetes. *Br J Ophthalmology*. 1990; 74: 654-660.