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Impact of Axial Length on Ocular Health in Patients with Diabetes: A Clinical Study

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Abstract

Diabetes mellitus, a chronic metabolic disorder marked by hyperglycemia, significantly impacts global public health, with approximately 537 million adults affected worldwide. Among its numerous complications, ocular health issues like diabetic retinopathy (DR) are prominent, leading to vision impairment and blindness in working-age adults. This study explores the relationship between axial length and ocular health outcomes in diabetic patients. This cross-sectional study was conducted at a tertiary eye care center, involving 100 diabetic patients divided into two groups: 50 without DR and 50 with DR. Comprehensive ophthalmic examinations were conducted, including best corrected visual acuity, slit-lamp biomicroscopy, intra ocular pressure measurement, fundus examination and optical coherence tomography. Axial length was measured using the IOLMaster. The presence and severity of DR were classified according to the International Clinical Diabetic Retinopathy Disease Severity Scale. Statistical analyses included independent t-tests, Pearson's correlation coefficient one-way ANOVA. The mean axial length was slightly higher in patients without DR (23.6 mm) compared to those with DR (23.2 mm), though not statistically significant (P=0.087). There was a significant decrease in axial length with increasing DR severity (P=0.045 for mild NPDR vs. no DR). Axial length negatively correlated with intra ocular pressure, significantly for patients with axial lengths < 22 mm and > 24 mm. Longer axial lengths were associated with thinner central retinal thickness, smaller macular volumes, better visual acuity deeper anterior chamber depths. This study suggests that shorter axial lengths are associated with higher prevalence and severity of DR. Axial length negatively correlates with intra ocular pressure and influences various ocular parameters. These findings underscore the need for further research to elucidate the mechanisms and potential clinical applications of axial length in diabetic eye care.

INTRODUCTION

Diabetes mellitus, a chronic metabolic disorder characterized by hyperglycemia, has become a significant public health concern worldwide. The International Diabetes Federation (IDF) reports that approximately 537 million adults are living with diabetes, a figure projected to rise significantly in the coming decades[1]. Among the numerous complications associated with diabetes, ocular health issues are particularly prominent, with diabetic retinopathy (DR) being a leading cause of vision impairment and blindness in working-age adults[2].

Diabetic retinopathy is a progressive retinal micro vascular complication of diabetes that manifests in stages ranging from mild non-proliferative diabetic retinopathy (NPDR) to proliferative diabetic retinopathy (PDR), with the latter posing a higher risk of severe vision loss[3]. The pathophysiology of DR involves a complex interplay of metabolic and hemodynamic changes leading to retinal ischemia, inflammation neovascularization. Despite advancements in the understanding and management of DR, predicting its onset and progression remains challenging, necessitating further research into potential risk factors and biomarkers[4].

Axial length, defined as the distance from the anterior corneal surface to the retina's inner limiting membrane, is a critical ocular parameter influencing refractive status and ocular health. Variations in axial length have been linked to several ocular conditions, including myopia, glaucoma age-related macular degeneration . However, its relationship with diabetic retinopathy is less clear, warranting detailed investigation[5].

Existing literature presents conflicting evidence regarding the impact of axial length on the development and progression of DR. Some studies suggest that longer axial lengths might confer a protective effect against DR due to reduced retinal oxygen demand and metabolic activity. Conversely, other research indicates that shorter axial lengths might be associated with increased susceptibility to DR, potentially due to structural and functional retinal alterations. These discrepancies highlight the need for comprehensive studies to elucidate the role of axial length in DR[6].

Furthermore, intra ocular pressure (IOP) and other ocular parameters such as central retinal thickness, macular volume, visual acuity anterior chamber depth are crucial in managing diabetic patients. Understanding how axial length influences these parameters in diabetic individuals can provide insights into tailored screening and treatment strategies.

Aims and Objectives: To investigate the relationship between axial length and ocular health outcomes in patients with diabetes.

- To measure and compare the axial lengths in diabetic patients with and without diabetic retinopathy.
- To assess the correlation between axial length and the severity of diabetic retinopathy.
- To evaluate the influence of axial length on intra ocular pressure and other ocular parameters in diabetic patients.

MATERIALS AND METHODS

Study Design and Participants: This clinical study was a cross-sectional analysis conducted at a tertiary eye care center. The study included 100 diabetic patients, divided into two groups: 50 diabetic patients without diabetic retinopathy (DR) and 50 diabetic patients with DR. The inclusion criteria were:

- Diagnosed diabetes mellitus (Type 1 or Type 2)
- Age between 40 and 70 years
- Clear ocular media allowing reliable ocular measurements

Exclusion Criteria Were:

- History of ocular surgery (except cataract surgery)
- Any ocular pathology other than DR (e.g., glaucoma, macular degeneration)
- Systemic diseases affecting ocular health other than diabetes

Ethical Considerations: The study protocol adhered to the tenets of the Declaration of Helsinki and was approved by the institutional review board (IRB). Written informed consent was obtained from all participants after explaining the nature and possible consequences of the study.

Clinical Assessment: All participants underwent a comprehensive ophthalmic examination including:

- Best corrected visual acuity (BCVA) measured using the Early Treatment Diabetic Retinopathy Study (ETDRS) chart
- Slit-lamp biomicroscopy
- Intra ocular pressure (IOP) measurement using Goldmann applanation tonometry
- Fundus examination with dilated pupils using binocular indirect ophthalmoscopy and fundus photography
- Optical coherence tomography (OCT) for central retinal thickness and macular volume measurement

Axial Length Measurement: Axial length was measured using the IOLMaster (Carl Zeiss Meditec, Jena, Germany), which employs partial coherence interferometry. Three consecutive measurements were taken for each eye the average value was recorded.

Classification of Diabetic Retinopathy: The presence and severity of DR were classified according to the International Clinical Diabetic Retinopathy Disease Severity Scale:

- No DR
- Mild non-proliferative DR (NPDR)
- Moderate NPDR
- Severe NPDR
- Proliferative diabetic retinopathy (PDR)

Data Collection: Demographic and clinical data were collected, including:

- Age
- Gender
- Duration of diabetes
- Glycated hemoglobin (HbA1c) levels
- Body mass index (BMI)

Statistical Analysis: Statistical analyses were performed using SPSS software (version 25.0, IBM Corp, Armonk, NY). The primary outcome measures were the differences in axial length between diabetic patients with and without DR the correlation of axial length with the severity of DR and other ocular parameters.

Descriptive statistics were used to summarize the data. Continuous variables were expressed as mean ± standard deviation (SD) and categorical variables as frequencies and percentages. Independent t-tests were used to compare means between groups. Pearson's correlation coefficient was employed to assess the relationship between axial length and intraocular pressure. One-way ANOVA was used to analyze differences in ocular parameters across different axial length groups. A $P<0.05$ was considered statistically significant.

Outcome Measures: The primary outcome measure was the difference in mean axial length between diabetic patients with and without DR. Secondary outcome measures included the correlation of axial length with:

- Severity of DR
- Intraocular pressure
- Central retinal thickness
- Macular volume
- Visual acuity
- Cup-to-disc ratio
- Anterior chamber depth

RESULTS AND DISCUSSIONS

(Table 1) presents the demographic and clinical characteristics of the study participants, comparing those without diabetic retinopathy (DR) to those with DR. The mean age of patients without DR is 56.3 years, while for those with DR, it is 58.7 years, with no significant difference ($P = 0.234$). Gender distribution is similar between the groups. Duration of diabetes and HbA1c levels are significantly higher in patients with DR ($P = 0.003$ and $P = 0.001$, respectively). BMI is not significantly different between the groups.

(Table 2) summarizes the axial length measurements in diabetic patients, distinguishing those with and without DR. The mean axial length is slightly higher in patients without DR (23.6 mm) compared to those with DR (23.2 mm), though this difference is not statistically significant ($P = 0.087$). The range and median values also reflect a slight difference between the groups but without statistical significance.

(Table 3) explores the relationship between the severity of diabetic retinopathy and axial length. As DR severity increases, the mean and median axial length tend to decrease. The mean axial length for mild NPDR is 23.3 mm, which decreases to 22.8 mm for PDR. This trend is statistically significant for mild NPDR compared to no DR ($P = 0.045$).

(Table 4) investigates the correlation between axial length and intraocular pressure in diabetic patients. There is a significant negative correlation between axial length and intraocular pressure for patients with axial lengths < 22 mm ($P = 0.029$) and > 24 mm ($P = 0.042$). The correlation is not significant for those with axial lengths between 22 and 24 mm.

(Table 5) details the relationship between various ocular parameters and axial length in diabetic patients. Significant differences are found across different axial length groups for central retinal thickness, macular volume, visual acuity anterior chamber depth. Patients with longer axial lengths tend to have thinner central retinal thickness, smaller macular volume, better visual acuity deeper anterior chamber depth. The cup-to-disc ratio shows a trend towards being lower with longer axial length but is not statistically significant ($P = 0.056$).

The current study investigates the impact of axial length on ocular health in diabetic patients, particularly in relation to diabetic retinopathy (DR). This section discusses our findings in the context of previous research, highlighting similarities and differences.

Axial Length and Diabetic Retinopathy: Our study found that diabetic patients with DR had a slightly shorter mean axial length compared to those without DR (23.2 mm vs. 23.6 mm), although this difference was not statistically significant ($P = 0.087$). This finding

Table 1: Demographic and Clinical Characteristics of Study Participants

Variable	Diabetic Patients without DR (n=50)	Diabetic Patients with DR (n=50)	p-value
Age (years)	56.3±10.2	58.7±9.8	0.234
Gender (M/F)	28/22 (56%/44%)	30/20 (60%/40%)	0.678
Duration of Diabetes (years)	8.4± 6.1	12.3±7.5	0.003*
HbA1c (%)	7.1±1.3	8.2±1.5	0.001*
BMI (kg/m²)	28.4±4.3	29.1±4.6	0.456

Table 2: Axial Length Distribution in Diabetic Patients

Axial Length (mm)	Diabetic Patients without DR (n=50)	Diabetic Patients with DR (n=50)	p-value
Mean ± SD	23.6±1.2	23.2±1.4	0.087
Range	21.0-26.5	20.8-26.0	
Median (IQR)	23.5 (22.8-24.4)	23.0 (22.3-24.2)	0.094

Table 3: Severity of Diabetic Retinopathy and Axial Length

Severity of DR	Mean Axial Length (mm) ± SD	Median Axial Length (mm) (IQR)	P-value
No DR	23.6±1.2	23.5 (22.8-24.4)	0.045*
Mild NPDR	23.3±1.1	23.2 (22.7-24.0)	
Moderate NPDR	23.1±1.3	22.9 (22.4-23.8)	
Severe NPDR	23.0±1.2	22.8 (22.2-23.5)	
PDR	22.8±1.4	22.6 (22.1-23.4)	

Table 4: Correlation Between Axial Length and Intralobular Pressure in Diabetic Patients

Axial Length (mm)	Intra ocular Pressure (mmHg) ± SD	Pearson Correlation Coefficient	p-value
< 22	16.5±2.3	-0.32	0.029*
22-24	15.8±2.1	-0.12	0.334
> 24	14.9±2.5	-0.28	0.042*

Table 5: Ocular Parameters and Axial Length in Diabetic Patients

Ocular Parameter	Axial Length < 22 mm (Mean±SD)	Axial Length 22-24 mm (Mean±SD)	Axial Length > 24 mm (Mean±SD)	P-value
Central Retinal Thickness (μm)	290±34	282±30	276±28	0.038*
Macular Volume (mm³)	8.7±0.5	8.5±0.6	8.3±0.4	0.047*
Visual Acuity (logMAR)	0.3±0.1	0.2±0.1	0.1±0.1	0.024*
Cup-to-Disc Ratio	0.5±0.1	0.4±0.1	0.3±0.1	0.056
Anterior Chamber Depth (mm)	3.0±0.4	3.2±0.3	3.4±0.3	0.042*

aligns with several previous studies. For instance, Michael[7]. reported a similar trend where patients with longer axial lengths had a lower prevalence of DR. However, our study's lack of statistical significance could be attributed to the sample size or other confounding factors not accounted for in this study.

In terms of severity, our results demonstrated a significant decrease in axial length with increasing severity of DR (P = 0.045 for mild NPDR vs. no DR), which corroborates with the findings of other studies like Man[8]. who found that axial length inversely correlated with the severity of DR. This inverse relationship might be due to the structural and biomechanical changes in the eye associated with both the progression of diabetes and elongation of the eyeball.

Axial Length and Intralobular Pressure: We observed a significant negative correlation between axial length and intraocular pressure (IOP) in diabetic patients, particularly in those with axial lengths <22 mm and >24 mm (P = 0.029 and P = 0.042, respectively). This is consistent with the findings of studies such as those by Ashish[9], which indicated that longer axial lengths are associated with lower IOP . The physiological basis for this correlation could be the larger ocular volume in longer eyes, which might facilitate better aqueous humor dynamics, thus reducing IOP.

Ocular Parameters: Our study found significant differences in ocular parameters such as central retinal thickness, macular volume, visual acuity anterior chamber depth across different axial length groups. Notably, patients with longer axial lengths tended to have thinner central retinal thickness and smaller macular volumes, better visual acuity deeper anterior chamber depths. These findings are in line with studies by Jost[11] which also noted that longer axial lengths are associated with these ocular changes, likely due to the stretching of ocular tissues as the eye elongates.

However, the cup-to-disc ratio, although showing a trend towards being lower with longer axial length, was not statistically significant in our study (P = 0.056). This contrasts with some studies, such as that by Flitcroft[12], which found a significant association between axial length and cup-to-disc ratio. The discrepancy might be due to variations in measurement techniques or population differences.

Limitations: Our study has several limitations that must be considered:

- Although we accounted for some confounders like age, gender, duration of diabetes HbA1c levels, other factors such as blood pressure, lipid levels genetic predispositions were not controlled for.
- Axial length measurements can vary based on the equipment used and the technician's expertise. Standardization across different centers and more advanced imaging technologies could improve accuracy.

- Being conducted in a single center may limit the applicability of our findings to broader populations with different demographic and clinical characteristics.

CONCLUSION

This study highlights the complex relationship between axial length and ocular health in diabetic patients. We found that shorter axial lengths are associated with a higher prevalence and severity of DR. Additionally, axial length negatively correlates with IOP longer axial lengths are associated with thinner central retinal thickness, smaller macular volumes, better visual acuity deeper anterior chamber depths.

While our findings align with previous research, they also underscore the need for further studies to elucidate the underlying mechanisms and potential clinical applications. Addressing the limitations of our study, such as by increasing sample size, controlling for more confounding factors using longitudinal designs, will be crucial in advancing our understanding of axial length's impact on ocular health in diabetic patients.

Future research should also explore the potential of axial length as a predictive marker for DR progression and its integration into routine diabetic eye care protocols. This could potentially lead to earlier detection and more personalized management strategies for diabetic patients at risk of severe ocular complications.

REFERENCES

1. Home, Resources, diabetes L.W., Acknowledgment, FAQs, et al 2024. IDF Diabetes Atlas Reports | IDF Diabetes Atlas [Internet]., https://diabetesatlas.org/atlas-reports/
2. Kropp, M., O. Golubnitschaja, A. Mazurakova, L. Koklesova and N. Sargheini et al., 2023. Diabetic retinopathy as the leading cause of blindness and early predictor of cascading complications—risks and mitigation. EPMA J., 14: 21-42.
3. Shukla, U.V. and K. Tripathy, 2024. Diabetic Retinopathy [Internet]. In: StatPearls. , http://www.ncbi.nlm.nih.gov/books/NBK560805/
4. Wang, W. and A.C.Y. Lo, 2018. Diabetic retinopathy: Pathophysiology and treatments. Int. J. Mol. Sci., 19: 1816-1816.
5. Panda-Jonas, S., J.B. Jonas and R.A. Jonas, 2022. Photoreceptor density in relation to axial length and retinal location in human eyes. Sci. Rep., Vol. 12, No. 1 .10.1038/s41598-022-25460-3.
6. Wang, Q., Y.X. Wang, S.L. Wu, S.H. Chen and Y.N. Yan et al., 2019. Ocular axial length and diabetic retinopathy: The kailuan eye study. Invest. Opthalm. and amp., Visual Sci., 60: 36-89.
7. Quigley, M.G. and V.J. Brown, 2013. Axial length and diabetic retinopathy. Ophthalmology, Vol. 120, No. 5 .10.1016/j.ophtha.2013.01.033.
8. Man, R.E.K., M.B. Sasongko, S. Sanmugasundram, T. Nicolaou and X. Jing et al., 2012. Longer axial length is protective of diabetic retinopathy and macular edema. Ophthalmology, 119: 1754-1759.
9. Kulshrestha, A., N. Singh, B. Moharana, P.C. Gupta, J. Ram and R. Singh, 2022. Axial myopia, a protective factor for diabetic retinopathy-role of vascular endothelial growth factor. Sci. Rep., Vol. 12 .10.1038/s41598-022-11220-w.
10. Jonas, J.B., L. Xu and Y.X. Wang, 2009. The Beijing eye study. Acta Ophthalmologica, 87: 247-261.
11. Flitcroft, D.I., 2012. The complex interactions of retinal, optical and environmental factors in myopia aetiology. Prog. Retinal Eye Res., 31: 622-660.