



Sonographic Evaluation of Optic Nerve Diameter (OND) In Diabetic and Non-Diabetic Subjects

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(Received: 16 January 2026

Revised: 25 February 2026

Accepted: 30 March 2026)

KEYWORDS:

Optic nerve diameter, Diabetes mellitus, Sonography

ABSTRACT:

Objective: To evaluate optic nerve diameter (OND) by using sonography in diabetic patients compared with healthy nondiabetic subjects.

Materials and Methods: A prospective cross sectional study conducted in department of Radiology & Imaging and Ophthalmology. BIRDEM General Hospital, Dhaka during the period of 1st January 2024 to 31st December 2025. There were 321 adult participants recruited to the study. Among them 163 Type 2 diabetic (DM II) patients and 158 apparently healthy, nondiabetic subjects. The OND was measured using a high-resolution dedicated ultrasound device. The ultrasound examinations were performed using a 10-MHz linear array transducer (Philips Affiniti 50). Subjects were examined in a supine position with their eyes closed. Three measurements of the OND were taken and the average recorded.

Results: The mean OND of the DM II patients was 3.12 ± 0.15 mm (range of 2.4–4.0 mm), which was significantly ($P < .05$) lower than the control subjects (4.24 ± 0.16 mm). Linear relationship between the duration of diabetic with optic nerve diameter was found.

Conclusion: The study concluded that diabetes affected the OND and it was significantly decreased than that in healthy controls. This imaging biomarker has the potential to transform visual care for DM II patients.

Introduction:

The chronic hyperglycaemia is associated with long term damage, dysfunction and failure of various organs, especially eyes, kidneys, nerves, heart and blood vessels¹

The incidence of diabetes mellitus (DM) is growing rapidly worldwide,²⁻⁴ with the global estimate at 171 million as of 2020.⁵ In Bangladesh, the incidence of diabetes mellitus is rising, with an estimated 13.1 million people currently affected, making it the 8th highest globally. Projections indicate a rise to 22.3 million people by 2045, moving Bangladesh to the 7th position, according to the International Diabetes Federation (IDF)

The optic nerve (ON) is the nerve of vision, it enters the orbit from the middle cranial fossa by passing through the optic canal; it is recognized as cranial nerve II. Diabetes is not a single disease but the pathological and metabolic state caused by inadequate insulin action.⁶ It

is characterized by tendency to hyperglycemia and to development of atherosclerosis, retinopathy, neuropathy and nephropathy and it is major factor for coronary heart disease.⁷ Visual problems are associated with brain, endocrine, and other systemic disorders⁸. For this reason, measuring the optic pathway can be a critical diagnostic tool and predictor for many neuro and endocrine pathologies.

DM II is the leading cause of blindness in persons aged 20 to 70 years, and statistics indicates that diabetics are 20 times more likely to develop blindness, than non diabetic subject.^{9,10} The optic nerve is one important structure affected by DM II.⁵ The optic nerve and small blood vessels of the eye can be damaged when blood sugar levels are out of control. Changes involving the optic nerve may serve as a useful indicator of impending or existing optic nerve neuropathy, in diabetic patients. These changes can affect the morphometry of the optic



nerve. Sonography is useful in optic nerve evaluation and can detect any changes in its morphometric value.¹¹

The integration of optic nerve diameter (OND) as an imaging biomarker into the routine diagnostic evaluation of diabetic patients could significantly improve visual care, among this group. The research objective was to determine if any sonographic difference exists in the OND in patients who have DM II, compared with nondiabetic patients

Materials and Methods

A prospective cross sectional study was carried out in department of Radiology & Imaging and Ophthalmology, BIRDEM General Hospital, Dhaka during the period of 1st January 2024 to 31st December 2025. This study recruited 321 adults, of which 163 were DM II patients and 158 apparently healthy, non diabetic subjects. Only diabetic patients with fasting blood sugar of 7.0 mmol/L or more and an ametropic eye were included in this study. Patients with type I DM were excluded from the study. The control group consisted of apparently healthy adult volunteers, who came for fasting. On arrival to the imaging room, the investigation was explained to patients and non diabetic healthy subjects. Only the patients and volunteers who gave their informed consent were recruited to the study.

Demographic information was prospectively recorded and substantiated by means of inspection of medical records. Information included the subject's age, sex, medical history, clinical history of duration of diabetics, followed by sonographic measurement of OND. The OND was measured using a high-resolution dedicated ultrasound equipment system (Philips Affiniti 50) and a 10-MHz linear array transducer



Fig: 1 A sonographic image with measurement showing the measurement of OND in diabetes type 2 patient (OND = 2.48 mm)



Fig: 2 A sonographic image with measurement showing the measurement of OND in non diabetic subject (ONH= 4.32 mm)

Results

This study was carried out in 321 subjects. Out of them, 163 were diagnosed cases of diabetic patients and 158 were non diabetic healthy subjects. They were divided into male and female groups. Out of which 88 were male and rest 75 were female patients in DM. In non diabetic subjects 87 were male and rest 71 were female. The mean age of the diabetic patients were 62.6 ± 7.6 years and a range of 30–80 years. The mean age of the non diabetic subjects were 56.5 ± 9.6 years, ranging from 34 to 75 years.

Table 1

The Demographic and Laboratory Values of DM II Patients and Non diabetic subjects.

Variables	Diabetic	Control	P Value
Age (years)	62.6 ± 6.4	55.2 ± 7.8	.532
Fasting plasma glucose (mmol/L)	11.2 ± 4.1	4.7 ± 1.2	.001
HbA1c (%)	8.73 ± 2.2	5.1 ± 1.3	.002*

In Table 1, the demographics and laboratory values of DM II and healthy subjects are provided. Most of the laboratory variables (hemoglobin A1c and fasting plasma glucose) were statistically different between DM



II patients and health volunteers. Participants with a significant reduction in optic nerve size were DM II patients with a high hemoglobin A1c concentration.

Table 2

The Strength of Association Between OND With the Clinical Biomarkers Collected From DM II Patients.

Variables	OND	
	R	P
Age (years)	.0	.61
Duration of diabetes (years)	-.36	.000*
HbA1c value (%)	-.55	.001*
Fasting blood sugar (mg/dL)	-.18	.059*

In table 2, Results showed that OND demonstrated a significantly moderate negative correlation with HbA1c ($r = -0.55$; $P < .05$), while a significantly weak negative correlation existed between OND and a fasting blood sugar ($r = -0.18$; $P < .05$). The OND and duration of DM II also had a significantly weak negative correlation ($r = 0.36$; $P < .05$)

Table 3

The Age Distribution of OND in the DM II Patients and Non diabetic subjects.

	Diabetic Subjects	Non diabetic Subjects	
Age Group	Mean OND \pm SD(mm) (N=163)	Mean OND \pm SD(mm) (N=158)	P Value
30–39	3.88 \pm 0.18 22	4.35 \pm 0.18 58	.248
40–49	3.13 \pm 0.15 8	4.52 \pm 0.19 42	.058
50–59	3.12 \pm 0.16 53	4.24 \pm 0.17 27	.005*

60–69	2.22 \pm 0.17 45	4.33 \pm 0.18 17	.001*
70–79	2.13 \pm 0.15 35	4.23 \pm 0.16 14	.002

The mean OND of the DM II patients was 3.12 ± 0.15 mm (range of 2.4–4.0 mm), which was significantly ($P < .05$) lower than the control subjects (4.24 ± 0.16 mm).

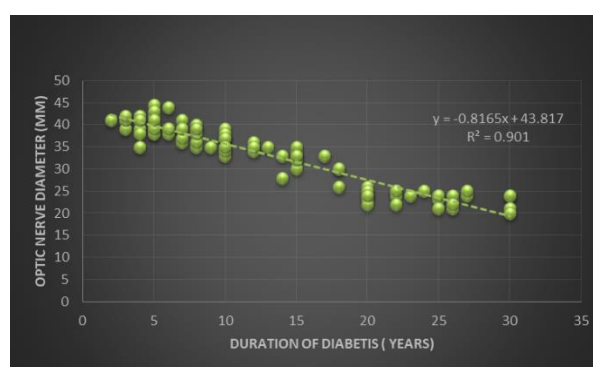


Figure : Relation between duration of diabetic and optic nerve diameter.

Fig -3 :Scatter plot diagram showing the Linear relationship between the duration of diabetic with optic nerve diameter , when the duration of diabetic increased the diameter decreased $R^2 = 0.901$

Discussion

This cross sectional study was carried out with an objective to evaluate the usefulness of non-invasive sonographic measurement of optic nerve diameter in diabetic patients compared with healthy non diabetic subjects.

Optic nerve involvement is a typical complication with diabetes and the pathogenesis has been documented in recent studies.^{5,12} The present study determined the OND and related values with some clinical biomarkers in adults with both poorly controlled DM II patients and their healthy counterparts. The mean OND for the DM II subset of participants was 3.10 ± 0.14 mm, within a range of 2.6–4.3 mm. This value was observed to be significantly lower than that of the healthy volunteers (see Table 3) and was comparable to a study conducted by Osman et al,¹³ with a cohort of diabetic Sudanese. The lowered OND in the diabetic patients, according to recent studies, has been linked to degenerative changes from



alterations in metabolic pathways, oxidative stress, hemodynamic changes, and ischemia, attributed to DM.^{5,12,14,15} Skillern and Lockhart¹⁶ had previously documented this finding with a series of fourteen uncontrolled diabetics, who they observed had developed optic nerve atrophy, as well as a few cases of retinopathic changes. Recent studies have underpinned a sorbitol pathway of glucose metabolism in the etiology of diabetic complications.

There are clinical manifestations of optic nerve changes with diabetic retinopathy (DR), such as diabetic papillopathy, neovascularization of optic disk, and optic nerve atrophy imposed by metabolic alterations related to DM, production of advanced glycation products (AGEs), oxidative stress, and hemodynamic changes.^{5,12} In addition, available evidence highlights pathways such as a vascular phenomenon related to occlusion of optic nerve nutrients, capillary changes in the superficial optic disk, and toxic metabolic changes to cause optic nerve involvement, in uncontrolled DM.^{12,17}

When comparing OND values, in the present study, between the subsets of participant, according to age, it yielded a significant difference between DM II and the healthy volunteers, in those 60 years and older. The DM II group had lower dimensions of OND than the control; however, for participants in their 40s and 50s, findings revealed a statistical homogeneity. In addition, the present study revealed that age did not influence OND among the DM II patients, as there was no statistical relationship established between these two variables. This outcome differs with the results of Sahar and Osman,¹³ which revealed a linear relationship between diabetic patient's age and optic nerve measurement.

The current study patients with a significant reduction in OND were diabetics with high glycated Hemoglobin A1c concentration (HbA1c), while nondiabetic volunteers had significantly lower HbA1c values and higher OND values (see Table 1). It turned out that OND reduced moderately with higher values of HbA1c in the DM II group (see Table 2), and this result would suggest that the impact of DM on OND and its association with HbA1c levels, is evident compared with similar research.^{11,12,18} HbA1c, an indicator of blood glucose concentrations over the preceding 3 months, is useful for characterizing dysglycemia in population studies and for

assessing the severity of DM and diabetic optic neuropathy.^{5,11}

In a study by Hua et al.,¹² they examined the relationship between the level of HbA1c, and progression of DR in a large cohort of diabetic persons. Their results showed a positive relationship between incidence and progression of retinopathy and glycated hemoglobin, after controlling for duration of diabetes, age, sex, and baseline retinopathy. Hua et al. added that glycated hemoglobin concentration seemed to explain most of the excess mortality risk with diabetes. HbA1c is a well-known predictive biomarker with regard to severity of DM and a propensity for complications. Its relationship with OND in the present study suggests that OND could be a useful predictive index for DM severity and risk of visual complication, and could transform care for DM II patients. There are instances where the HbA1c value can be influenced by other nonglycemic factors, such as any defect in the concentration of hemoglobin, conditions that lengthen the red blood cell lifespan, and iron deficiency.^{11,19} If this happens, results may become misleading and the patient's management compromised there might be need to integrate such morphometric biomarker as OND to determine severity and improve care for DM II patients.

The duration of DM, explored in this study, showed a weak negative correlation with OND, after controlling for other variables for patients with poorly controlled diabetes (see Table 2). Findings in this regard were in agreement with a study conducted by Osman et al.,¹³ however, was opposed to result by Eda et al.,²⁰ who argued that OND did not change with severity of DM. In their study, it was stated that pre-treatment of the OND for patients diagnosed with one of the acute hyperglycemic complications was not different from their healthy counterparts.

Linear relationship between the duration of diabetic and right optic nerve measurements was found. when the duration of diabetic increased the measurement decreased by -10.16 starting from 37.47 mm $r^2 = 0.094$ and for left optic nerve measurement, when the duration of diabetic increased, the measurement decreased by -16.66 starting from 53.24mm $r^2 = 0.193$. Fig(2,3). The justification taken for those facts is because in diabetic patients the nerve fiber layer is decreased, particularly in the superior segment of the retina, even before the



development of clinical presentation. it was mentioned that the nerve fiber layer thickness decreases with the development of diabetic retinopathy and with impairment of metabolic regulation of diabetic.²¹Elevated blood glucose levels cause an elevated retinal glucose level, resulting in a hypoxic – imbalance that may contribute to the ischemia those precedes the development of diabetic retinopathy. ²¹

Conclusion :

In this study DM II patients had a significantly narrower OND than their control counterparts. This may suggest that one of the reasons for poor vision among diabetic patients is a reduction in OND. Sonographic imaging as measuring the OND may facilitate for early prediction and detection of changes of elevated diabetic change in the optic nerve.

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