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# A Case Control Study on Type 2 Diabetes Mellitus as a Risk Factor of Open Angle Glaucoma in Patients Attending at a Tertiary Care Centre of West Bengal .

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## ABSTRACT

**Background:** Type 2 Diabetes Mellitus (T2DM) is one of the most prevalent non-communicable diseases in India and has been implicated in several ocular complications. Open Angle Glaucoma (OAG) is a leading cause of irreversible blindness globally. This study investigates the association between T2DM and OAG in a tertiary care setting in West Bengal. **Objectives:** To determine the prevalence of OAG in patients with T2DM and to assess the strength of association between T2DM and OAG compared to non-diabetic controls. **Methods:** A hospital-based case-control cum cross-sectional study was conducted at the Ophthalmology outpatient department of a tertiary care centre in West Bengal. A total of 82 participants (41 cases with T2DM and 41 age- and sex-matched controls without diabetes) were enrolled using purposive sampling. Sample size was calculated using standard formula. Sociodemographic data, clinical examination, intraocular pressure (IOP) measurement, and ophthalmoscopic assessment were performed for all participants. **Results:** Open Angle Glaucoma was found in 43.9% of diabetic cases and 17.1% of non-diabetic controls. The odds ratio (OR) was 3.77 (95% CI: 1.35–10.5, p = 0.009), indicating a statistically significant association. Elevated IOP was more common in cases (53.7%) than controls (22.0%). Longer duration of diabetes (>10 years) and poor glycaemic control (HbA1c >7%) were identified as significant risk modifiers. **Conclusion:** T2DM is a significant and independent risk factor for the development of Open Angle Glaucoma. Routine ophthalmological screening in all diabetic patients is strongly recommended to prevent vision-threatening complications.

**Keywords:** Type 2 Diabetes Mellitus, Open Angle Glaucoma, Intraocular Pressure, Risk Factor, West Bengal, Case-Control Study

## 1. INTRODUCTION

Diabetes Mellitus is a global public health emergency of the 21st century. According to the International Diabetes Federation (IDF), India harbours the second largest diabetic population in the world, with approximately 77 million people living with diabetes as of 2019. West Bengal, being one of the most populous states, contributes significantly to this burden[1]. Type 2 Diabetes Mellitus (T2DM), characterised by insulin resistance and progressive beta-cell dysfunction, is associated with a wide spectrum of microvascular and macrovascular complications that affect multiple organ systems, including the eye[2].

Amongst the ocular complications of T2DM, diabetic retinopathy has received considerable attention. However, the relationship between T2DM and Open Angle Glaucoma (OAG) has been a subject of increasing research interest in recent decades. Glaucoma is a group of progressive optic neuropathies characterised by irreversible optic nerve damage and visual field loss, with elevated intraocular pressure (IOP) being the primary modifiable risk factor[3]. Open Angle Glaucoma is the most common form, often asymptomatic in early stages, leading to late diagnosis and significant loss of vision[4].

Several pathophysiological mechanisms have been proposed to explain the association between T2DM and OAG. These include impaired aqueous humour drainage due to glycation of trabecular meshwork proteins, autonomic neuropathy affecting ocular vasculature, and oxidative stress-mediated retinal ganglion cell apoptosis. Studies from various parts of the world, including South-East Asia, have suggested a two- to three-fold increased risk of OAG amongst diabetic patients[5].

In the Indian context, studies specifically addressing this association remain limited, particularly from eastern India. There exists a considerable gap in literature from tertiary care centres of West Bengal. This study was therefore planned with the aim of evaluating the role of T2DM as a risk factor for Open Angle Glaucoma in a hospital-based setting.

## 2. OBJECTIVES

Primary Objective: To determine the prevalence of Open Angle Glaucoma amongst patients with Type 2 Diabetes Mellitus attending the ophthalmology outpatient department of a tertiary care centre in West Bengal.

Secondary Objectives: (i) To compare the occurrence of OAG between diabetic cases and non-diabetic controls. (ii) To assess the association between duration of diabetes, glycaemic control (HbA1c), and the development of OAG. (iii) To study the sociodemographic profile of the study participants.

# 3. METHODOLOGY

## 3.1 Study Design and Setting

This was a hospital-based case-control cum cross-sectional study conducted at the Ophthalmology Outpatient Department of a tertiary care medical college and hospital in West Bengal. The study was carried out over a period of six months from January 2024 to June 2024 after obtaining ethical clearance from the 784 Institutional Ethics Committee.

## 3.2 Sample Size Calculation

Sample size was calculated using the standard formula for case-control studies:

$$n = Z^2\alpha/2 \times P(1-P) \times 2 / d^2$$ Where: Zα/2 = 1.96 (at 95% confidence level), P = expected proportion of OAG in diabetics = 0.30 (based on prior literature), d = allowable error = 0.10 (10%).

$$n = (1.96)^2 \times 0.30 \times 0.70 \times 2 / (0.10)^2 = 80.67 \approx 82$$

Thus, a total of 82 participants were enrolled: 41 cases (T2DM patients with OAG risk) and 41 controls (non-diabetic subjects), matched for age (±5 years) and sex.

## 3.3 Sampling Method

Purposive (non-probability) sampling was employed for this study. Participants fulfilling the inclusion criteria attending the ophthalmology OPD during the study period were consecutively enrolled until the required sample size was achieved. Cases were T2DM patients aged 40 years and above, confirmed by prior diagnosis or fasting blood glucose ≥126 mg/dL on two separate occasions. Controls were age- and sex-matched individuals without T2DM attending for routine eye check-up or non-glaucoma complaints.

## 3.4 Inclusion and Exclusion Criteria

Inclusion criteria for cases: Diagnosed T2DM patients aged ≥40 years, willing to give written informed consent. Inclusion criteria for controls: Non-diabetic individuals aged ≥40 years, willing to participate.

Exclusion criteria: Patients with secondary glaucoma, a history of ocular surgery or trauma, angle-closure glaucoma, Type 1 Diabetes Mellitus, or those on steroid therapy (systemic or topical) were excluded from both groups.

## 3.5 Data Collection and Clinical Assessment

A predesigned, pretested structured proforma was used to collect sociodemographic data including age, sex, residence, education, and occupation. Clinical assessment included measurement of fasting blood glucose, HbA1c, duration of diabetes, visual acuity, slit-lamp examination, Goldmann applanation tonometry for IOP measurement, gonioscopy, and fundus examination with 90D lens for optic disc evaluation. Open Angle Glaucoma was diagnosed using the criteria of IOP >21 mmHg on two separate occasions, typical optic disc cupping (Cup-to-Disc ratio >0.6), and corresponding visual field defects on automated perimetry.

## 3.6 Statistical Analysis

Data were entered in Microsoft Excel and analysed using SPSS version 23.0. Categorical variables were expressed as frequencies and percentages. Odds Ratio (OR) with 95% Confidence Interval (CI) was calculated to measure the strength of association. Chi-square test was used for comparison of proportions. A p-value of <0.05 was considered statistically significant.

# 4. RESULTS

## 4.1 Sociodemographic Profile of Study Participants

A total of 82 participants were studied – 41 diabetic cases and 41 non-diabetic controls. Table 1 presents the sociodemographic characteristics of both groups. The mean age of cases was 57.3 ± 8.2 years and that of controls was 54.6 ± 7.9 years. The majority of participants in both groups belonged to the 51–60 years age category. Males constituted 58.5% of cases and 53.7% of controls. Rural residents were predominant in both groups. Most participants had primary or secondary level of education. Farmers and housewives constituted the major occupational categories. The two groups were comparable with respect to all sociodemographic parameters ($p > 0.05$), ensuring homogeneity of the sample.

**Table 1: Sociodemographic Characteristics of Study Participants (n = 82)**

| Variable | Cases (n=41) | Controls (n=41) | Total (n=82) | p-value |
|---|---|---|---|---|
| **Age Group (Years)** | | | | |
| 40–50 yrs | 10 (24.4%) | 15 (36.6%) | 25 (30.5%) | |
| 51–60 yrs | 18 (43.9%) | 16 (39.0%) | 34 (41.5%) | |
| >60 yrs | 13 (31.7%) | 10 (24.4%) | 23 (28.0%) | 0.41 |
| Mean age ± SD | 57.3 ± 8.2 | 54.6 ± 7.9 | 55.9 ± 8.1 | |
| **Sex** | | | | |
| Male | 24 (58.5%) | 22 (53.7%) | 46 (56.1%) | |
| Female | 17 (41.5%) | 19 (46.3%) | 36 (43.9%) | 0.67 |
| **Residence** | | | | |
| Rural | 26 (63.4%) | 23 (56.1%) | 49 (59.8%) | |
| Urban | 15 (36.6%) | 18 (43.9%) | 33 (40.2%) | 0.49 |
| **Education Level** | | | | |
| Illiterate | 12 (29.3%) | 10 (24.4%) | 22 (26.8%) | |
| Primary/Secondary | 20 (48.8%) | 22 (53.7%) | 42 (51.2%) | |
| Higher Secondary+ | 9 (21.9%) | 9 (21.9%) | 18 (22.0%) | 0.83 |

| | | | | |
|---|---|---|---|---|
| Service/Business | 11 (26.8%) | 10 (24.4%) | 21 (25.6%) | |
| Retired/Unemployed | 6 (14.7%) | 6 (14.6%) | 12 (14.7%) | 0.91 |
| **Duration of Diabetes (Cases only)** | | | | |
| <5 years | 11 (26.8%) | – | – | |
| 5–10 years | 19 (46.3%) | – | – | |
| >10 years | 11 (26.8%) | – | – | – |
| **Occupation** | | | | |
| Farmer/Labourer | 14 (34.1%) | 13 (31.7%) | 27 (32.9%) | |
| Housewife | 10 (24.4%) | 12 (29.3%) | 22 (26.8%) | |

### 4.2 Prevalence of Open Angle Glaucoma and Clinical Associations

Table 2 presents the clinical findings and statistical association between T2DM and OAG. Open Angle Glaucoma was diagnosed in 18 (43.9%) of diabetic cases as compared to 7 (17.1%) of non-diabetic controls. The association was statistically significant (OR = 3.77, 95% CI: 1.35–10.5, p = 0.009), suggesting that diabetic patients have approximately 3.77 times higher odds of developing OAG compared to non-diabetics.

Elevated IOP (>21 mmHg) was found in 22 (53.7%) cases versus 9 (22.0%) controls (p = 0.002). Poor glycaemic control, defined as HbA1c >7%, was present in 26 (63.4%) diabetic cases. Amongst those with diabetes for more than 10 years, the risk of OAG was significantly higher (p = 0.03), indicating a doseresponse relationship between duration of diabetes and glaucoma risk. Family history of glaucoma, though numerically higher in cases, did not reach statistical significance (p = 0.26).

**Table 2: Clinical Findings and Association Between T2DM and Open Angle Glaucoma**

| Parameter | Cases n=41 (%) | Controls n=41 (%) | OR (95% CI) | p-value |
|---|---|---|---|---|
| Open Angle Glaucoma present | 18 (43.9%) | 7 (17.1%) | 3.77 (1.35–10.5) | 0.009 |
| Elevated IOP (>21 mmHg) | 22 (53.7%) | 9 (22.0%) | 4.11 (1.62–10.4) | 0.002 |

| | | | | |
|---|---|---|---|---|
| Family history of glaucoma | 10 (24.4%) | 6 (14.6%) | 1.87 (0.62–5.62) | 0.26 |
| HbA1c >7% | 26 (63.4%) | – | – | – |
| Duration of DM >10 yrs | 11 (26.8%) | – | Sig. risk factor | 0.03 |

## 5. DISCUSSION

The present study demonstrates a statistically significant and clinically meaningful association between Type 2 Diabetes Mellitus and Open Angle Glaucoma in a tertiary care setting of West Bengal. The prevalence of OAG among diabetic patients (43.9%) was considerably higher than that seen among nondiabetic controls (17.1%), with an odds ratio of 3.77 – a finding that carries significant public health implications[6].

These results are in consonance with several earlier studies conducted globally. Mitchell et al. (Blue Mountains Eye Study, Australia) reported that diabetics had a significantly higher prevalence of OAG compared to non-diabetics. Similarly, the Beaver Dam Eye Study from the United States noted a positive, though modest, association between diabetes and OAG. Closer to home, an Indian study by Raychaudhuri et al. from West Bengal reported a prevalence of glaucoma of approximately 12.7% in the general population, significantly higher in diabetics[7].

The pathophysiological basis for this association is multifactorial. Chronic hyperglycaemia leads to glycosylation of trabecular meshwork proteins, impairing the drainage of aqueous humour and resulting in elevated IOP. Additionally, microvascular ischaemia due to diabetes may compromise optic nerve perfusion, rendering the retinal ganglion cells more susceptible to pressure-induced apoptosis even at borderline IOP levels. Autonomic neuropathy may further reduce ocular blood flow autoregulation, exacerbating ischaemic optic neuropathy[8].

In the present study, elevated IOP was significantly more prevalent in diabetic patients (53.7% vs. 22.0%, $p = 0.002$). This finding aligns with the notion that hyperglycaemia adversely affects the trabecular outflow pathway. Furthermore, the observed dose-response relationship – wherein patients with diabetes duration exceeding 10 years had a significantly higher risk of OAG ($p = 0.03$) – supports the hypothesis that chronic cumulative metabolic insult to the ocular tissue over time promotes glaucomatous change.

The role of glycaemic control is equally noteworthy. In the current study, 63.4% of diabetic cases had HbA1c values exceeding 7%, suggesting suboptimal metabolic control. Several studies have demonstrated that poor glycaemic control, as reflected by HbA1c, is independently associated with elevated IOP and optic nerve damage. This underscores the importance of tight glycaemic control not only to prevent systemic complications, but also to protect ocular health[9].

The sociodemographic profile of this study reflects the typical patient demographic attending public tertiary care hospitals in eastern India – predominantly rural, middle-aged, and with limited formal education. These factors may contribute to delayed diagnosis and reduced access to specialist ophthalmological care. The predominance of rural participants underlines the need for strengthening primary eye care services and integrating glaucoma screening into existing diabetic care programmes at community and district hospital levels.

A notable strength of this study is the use of objective, standardised diagnostic criteria for both T2DM and OAG. The use of Goldmann applanation tonometry, gonioscopy, and automated perimetry ensures diagnostic rigour. The matched case-control design minimises confounding due to age and sex. However, certain limitations must be acknowledged. The relatively small sample size (n = 82) limits the generalisability of the findings. Being a hospital-based study, the results may not be representative of the community at large. Additionally, the cross-sectional design precludes the establishment of temporal causality between diabetes onset and glaucoma development[10].

Despite these limitations, this study adds meaningful data from a region that is underrepresented in glaucoma research literature and provides a basis for larger community-based longitudinal studies in the future.

## 6. CONCLUSION

The present study confirms that Type 2 Diabetes Mellitus is a significant and independent risk factor for Open Angle Glaucoma. Diabetic patients have approximately 3.77 times higher odds of developing OAG compared to their non-diabetic counterparts. Longer duration of diabetes and poor glycaemic control further amplify this risk. Given the silent and progressive nature of OAG, routine and periodic ophthalmological screening, including IOP measurement and fundus examination, should be made an integral component of diabetes management protocols in all tertiary care institutions. Early detection and timely intervention can substantially reduce the burden of glaucoma-related visual disability in the diabetic population of West Bengal and India at large.

### 7.DECLARATION

**Conflict of Interest**: The authors declare no conflict of interest.

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