
Research Article**Prevalence of Undiagnosed Glaucoma in Type 2 Diabetics Attending Outpatient Department at Regional Institute of Ophthalmology, Amritsar-A Hospital Based Study****Gupta K^{*1}, Kulshrestha R², Chahal JS³, Singh K³, Aggarwal A³, Gupta A³, Trehan A¹**¹BPS GMC for Women, Khanpur Kalan, Sonapat, Haryana, India²Modern Institute of Medical Sciences, Indore, Madhya Pradesh, India³Regional Institute of Regional Institute of Ophthalmology, Amritsar, Punjab, India***Corresponding author**

Dr. Khushboo Gupta

Email: drmrkul@gmail.com

Abstract: Diabetes and glaucoma share common pathophysiology and diabetes increase the risk of developing glaucoma. However the significance and impact of thorough eye examination for glaucoma in all diabetics is not clear in literature. The study was thus planned to evaluate the prevalence of undetected glaucoma and its extent in type 2 diabetics attending OPD at Regional Institute of Ophthalmology, Amritsar, tertiary care center. 100 confirmed cases (history and fasting glucose measurement) of type 2 diabetics were enrolled from OPD. Known cases of glaucoma were excluded. Glaucoma was detected by thorough eye examination including visual acuity, intra ocular pressure (IOP), optic disc changes, visual field changes and gonioscopy. The prevalence with type and extent of glaucoma was observed. The age of patients ranged from 30 -75 years, with 51% males. Total prevalence of undetected glaucoma was 9%. Seven patients were suffering from chronic simple glaucoma out of which 4 were males and 3 were females. Only 1 male patient was suffering from neovascular glaucoma and 1 female patient was suffering from narrow angle glaucoma. Type 2 diabetics have a high prevalence of undetected glaucoma (9%). Thorough examination for glaucoma in all type 2 diabetics can produce an acceptable yield of glaucoma cases helping prevent later ocular morbidity.**Keywords:** Diabetes, glaucoma, prevalence

INTRODUCTION

The prevalence of diabetics worldwide has risen from 30 million in 1985 to 177 million in the year 2000. The major part of this numerical increase will occur in the developing countries. In India alone, 57 million people may suffer from diabetes by the year 2025 [1].

Glaucoma can be defined as chronic progressive optic neuropathy caused by group of ocular conditions which leads to damage of optic nerve with loss of visual function, most common risk factor known is raised Intra ocular pressure (IOP). People with diabetes are 40% more likely to suffer from glaucoma than people without diabetes [2]. Risk is of two major types of primary glaucoma (Open angle glaucoma and Angle closure glaucoma) and secondary glaucoma (Neovascular glaucoma) [3].

Several large epidemiological studies have reported positive associations between diabetes with primary open angle glaucoma (POAG), the most common form of primary glaucoma, or elevated intraocular pressure in the absence of glaucoma optic

neuropathy. Open angle glaucoma: occurs more often in patient with diabetes (5%) than in the general population (2%) [3, 4]. The risk of glaucoma has been reported to be 1.6–4.7 times higher in individual with diabetes than in non-diabetic individuals [5]. Relative to those without diabetes, individual with diabetes may be more vulnerable to elevated intraocular pressure, with more severe visual field loss at the same intraocular pressure level [6]. Angle closure glaucoma (PACG): the other type of glaucoma is characterized by narrow or closed anterior chamber angles, which impedes drainage of aqueous humor and leads to raised intraocular pressure [7].

Armstrong et al. reported prevalence of POAG to be 4.1% in the diabetic patients compared with 1.4% in the controls [8]. Other studies revealed that participants with diabetes were twice as likely to have glaucoma as those without diabetes [9]. Bonovas S et al. Reported that OAG was 40% more prevalent in type 2 diabetic subjects, especially those with diseases of long duration. A 2004 Meta analysis concluded that diabetes increases the risk of primary OAG (POAG) by 1.5 fold [10]. An increased risk of progression of

POAG was reported in diabetic patients in the Advanced Glaucoma Intervention Study (AGIS) and Collaborative Initial Glaucoma Treatment Study (CIGTS) in 2011. The study found that people with diabetes had a 35 percent increased risk of developing POAG [11]. Kellogs S *et al.* reported that people with diabetes have a 35% higher chance of having Glaucoma than people who do not [12]. In the Blue Mountains and Beaver Dam Eye studies, participants with diabetes were twice as likely to have glaucoma as those without [13]. However, not all population-based studies have identified such an association [13].

Studies have shown a consistent association between diabetes and neovascular glaucoma [14], with proliferative retinopathy the leading cause of this type of secondary glaucoma. Between 32 and 43% of neovascular glaucoma cases are caused by proliferative diabetic retinopathy. Neovascularisation of the iris, an early precursor of neovascular glaucoma, is commonly seen in patients with long-standing poorly controlled diabetes. Hypoxia in the retina and other ocular tissue causes an increased expression of vascular endothelial growth factor (VEGF), which stimulates new vessel formation in the iris or in the anterior chamber angle. Neovascular glaucoma requires aggressive intervention to lower intraocular pressure with medication, followed by surgery [15-17]. Regression of neovascularisation following pan-retinal laser photocoagulation can occur if treated early [17].

Early detection of glaucoma can help in efficient management reducing patient morbidity. The study was thus planned to evaluate the prevalence of undetected glaucoma and its extent in Diabetics attending Outpatient Department at Regional Institute of Ophthalmology, Amritsar.

MATERIAL AND METHODS

The study was conducted on a total of 100 selected diabetic subjects (type 2 Diabetes Mellitus) attending the Outpatient department of Ophthalmology, Regional institute of Ophthalmology, Amritsar after explaining the nature of the study and obtaining their written consent. Ethical approval was taken from the institutional ethical committee Patients of either sex giving medical history of type 2 diabetes were included in the study. Diagnosis of diabetes was confirmed by estimation of fasting blood sugar levels. Patients with very dense cataract in whom perimetric and fundus changes were difficult to assess and patients who refused consent were excluded from the study. Patients already with documented glaucoma were excluded.

EXAMINATION AND PROCEDURE

A total of 100 diabetic patients from OPD were examined. Complete history and general physical examination was done in all the patients. Complete eye examination was done for both eyes. For detection of glaucoma the following parameters were assessed:

- Visual Acuity
- Intra ocular pressure (IOP), determined by Goldmann's Applanation tonometer
- Optic disc changes, assessed by direct and indirect ophthalmoscopy
- Visual field changes, assessed by perimetry (Humphrey's Field Analyser).
- Gonioscopy, done to differentiate open angle from closed angle glaucoma.

Intra ocular pressure was recorded by Goldmann's Applanation tonometer (Gold standard). It is based on the principle of applanation (Imbert Fick's law). It measures the force required to applanate a given area of the cornea at its centre.

Disc changes in a case of Glaucoma are as follows [18]:

- Asymmetry greater than 0.2 disc diameter between two eyes
- Cupping greater than 0.6 disc diameter
- Sharp margins or undermining of the cup
- Splinter hemorrhages at the disc
- Deep cup
- Notching of the cup
- Nasal displacement of vessels
- Pallor associated with cupping
- Baring of disc vessels
- Dilated veins
- Peripapillary atrophy
- Arterial pulsations

Out of all these changes, cup to disc (vertical) ratio is an important parameter which is the ratio of size of cup in relation to the total disc diameter [18]. Visual field defects in case of glaucoma can be detected by characteristic changes in graphs plotted by standard automated perimetry (SAP-Humphrey's field analyzer). Gonioscopic examination was done by indirect gonioscopes to classify the glaucoma patients into Open angle or Angle closure type.

Glaucomatous changes are thus assessed using the above parameters and methods to diagnose the type and presence of glaucoma. The data was compiled and statistically analyzed using Microsoft Excel and SPSS ver. 19 programs.

RESULT

Maximum number of patients (36%) were in the age group 50-59 years followed by 23% in 60-69 years and 22% in 40-49 years. 14% patients had age more than 70 years. 51% of the total patients were male and 49% female. In age group of 50-59 years there were more females (20) than males (16). 13 males and 10 females were present in age group 60-69 and 12 males and 10 females in age group 40-49. 7 each male and females had age more than 70 years. 47% patients were from rural and 53% patients were from urban areas.

Highest mean Intraocular Pressure of 16.5 mm was documented in the age group of 60-69 years followed by 14.8 mm in the age groups of 50-59 years and >70 years. Least mean Intraocular Pressure was 13.3 in the age group of 30-39 years. Mean Intraocular Pressure was 15.7 mm in the age group of 40-49 years. Mean intraocular pressure was significantly higher in females than males of age group 50-59 years (16.2 vs 13.4 mm, $p < 0.05$). Mean intraocular pressure was similar in males and females of other age groups.

A total of 9 patients were detected to have glaucoma (prevalence 9%). Maximum (4) were in age group of 50-59 years followed by 3 in age group 60-69 year and 2 in age > 70 years. Prevalence was similar all

the three age groups (50-59 yrs- 11.0%, 60-69 years – 13.0%, >70 years – 14.3%). 5 males and 4 female patients were suffering from glaucoma (Table 1). Maximum number of males (2) were having glaucoma in age group 60-69 years and >70 years of age each followed by 1 in age group 50-59 years. Maximum number of female patients (3) had glaucoma in age group 50-59 years followed by 1 in age group 60-69 years.

Total of 7 patients were suffering from chronic simple glaucoma out of which 4 were males and 3 were females. Only 1 male patient was suffering from neovascular glaucoma and 1 female patient was suffering from narrow angle glaucoma (Table 2).

Table-1: Prevalence of glaucoma in male and female diabetic patients

AGE IN YEARS	GLAUCOMA	
	MALE	FEMALE
50-59	1	3
60-69	2	1
>70	2	0
TOTAL	5	4

Table-2: Distribution of various types of clinical glaucoma in the study patients

TYPE OF GLAUCOMA	MALES	FEMALES	TOTAL
Chronic simple	4	3	7
Narrow angle	0	1	1
Neovascular	1	0	1

DISCUSSION

Similar number of male and female patients was enrolled in the study. Age range of patients was 30-75 years. The proportion of urban and rural patients was also similar reflecting the now widespread distribution of type 2 diabetes mellitus.

Mean intraocular pressure was significantly higher in females than males of age group 50-59 years (16.2 vs 13.4 mm, $p < 0.05$). The observation is consistent with fact that females have higher intraocular pressure and higher risk of glaucoma.² Mean intraocular pressure was similar in males and females of other age groups. This study found almost same mean pressure in diabetics with diabetic retinopathy as in those without retinopathy (16.02). There was no linear relationship between intraocular pressure and diabetic retinopathy. There was one patient with proliferative diabetic retinopathy (neovascular glaucoma) and hence its relationship with intraocular pressure could not be determined effectively. This observation is supported by Safir *et al.* [19] but is against the observation of Jain I.S. and Gill [20] and Jain and Luthra [21] who reported higher intraocular pressure in patients without retinopathy.

5 males and 4 females were suffering from glaucoma. Prevalence of glaucoma in male and female diabetics was similar, even though glaucoma is known to be more prevalent in females [2]. The total prevalence of undiagnosed glaucoma in diabetics was 9%, with 7% chronic simple or primary open glaucoma. Prevalence of primary angle closure glaucoma and neovascular glaucoma was 1% each.

The prevalence of primary open angle glaucoma in the general population has been reported to be 2-3% (Blue Mountain Study, West of Ireland study) [23]. POAG is more common with increasing age: nearly 55.7% of patients are aged 60 years and over [23]. In the diabetic patients, however higher prevalence of glaucoma was found in more patients at earlier age (50-59 years) in our study. Our findings of more prevalence of glaucoma in diabetics (9%) are supported by various studies in the literature [8,22].

There have been conflicting reports regarding the association of diabetes and open angle glaucoma, although a meta-analysis of previous study results has suggested that diabetic patients are at significantly increased risk of developing primary open angle glaucoma [10]. In the LALES cohort, the presence of type 2 diabetes mellitus (DM) and a longer duration of

the condition were independently associated with higher risk of OAG [24]. These findings were corroborated by Pasquale [25], whose study concluded that type 2 diabetes mellitus is associated with an increased risk of POAG in women. Chopra *et al.* [24] reported a prevalence of 13.6% and Dharmadhikari S *et al.* [26] reported a prevalence of 15.6%, much higher than the 9% prevalence observed in our study. This may be due the fact this study concentrated on prevalence of undiagnosed glaucoma in diabetics to clarify on the significance of universal screening for glaucoma in type 2 diabetics. The Beaver Dam Eye Study, which found an incidence of 7.8% of POAG in diabetics compared with 3.9% in those without diabetes ($P=0.0005$), concluded that the presence of open angle glaucoma is increased in people with older-onset diabetes [27].

Mean IOP was 21.33 in open angle glaucoma and 21.0 in primary closed angle glaucoma patients in this study. But the maximum mean IOP was only 16.5 in the age group of 60-69 years. The mean IOP in diabetics was not high. The significant and consistent association between diabetes and glaucoma found by the Blue Mountain study was independent of the effect of diabetes on IOP [9]. Dielemans investigated the association of POAG and IOP with newly diagnosed diabetes mellitus, and concluded that a 10 mmol/l rise in serum glucose on a glucose tolerance test was associated with an overall rise of mean IOP of 0.59 mm for high tension glaucoma [28].

Conversely, in the Rotterdam study, a prospective population-based study, De Voogd *et al.* concluded that diabetes mellitus was not a risk factor for OAG [29]. Ellis *et al.* demonstrated that a non-significant increase in diagnosis and treatment of the disease was observed in the diabetic population; however, evidence was also found that detection bias contributed to the association [30]. Tielsch *et al.* concluded that the Baltimore Eye Study, a population-based investigation, found no evidence to support an association between diabetes and POAG [13].

The low prevalence of neovascular glaucoma in this study may be due to lesser number of diabetics with a longer duration of the disease and thus lesser neovascularization and hemorrhages, the two most common complication causing secondary glaucoma in diabetics.

Untreated primary open angle glaucoma (POAG) is a blinding optic neuropathy. Timely medical or surgical treatment is effective in slowing the rate of optic nerve damage and delaying the onset of visually disabling field loss, but treatment is only effective in prevention, and there is as yet no means of reversing established axon loss. Further optic nerve damage occurs at a lower IOP compared with the non-diabetic open angle glaucoma population. Hence thorough

examination of all type 2 diabetics routinely for glaucoma can help reduce future morbidity.

CONCLUSION

After thorough examination of 100 diabetics it can be concluded that the prevalence of undetected glaucoma in diabetics is far more than the prevalence of glaucoma in general population. Majority of the patients were open angle glaucoma and rest two cases were neovascular glaucoma and angle closure glaucoma one each. Because of this, we believe it is important that all diabetics should be thoroughly examined for glaucoma.

REFERENCES

1. Emberth JR; American Diabetes Association: Clinical practice recommendations. *J Diabetes care*, 2007;30:S4; 2:2276-7.
2. Ritch R, Shields MB, Krupin T, editors; *The glaucomas*, 2nd Ed. St Louis : Mosby- Year Book, 1996 : 753-68
3. Kahn HA, Milton RC: Revised Framingham Eye Study prevalence of glaucoma and diabetic retinopathy. *Am J Epidemiol*, 1992; 111:769-776.
4. Reynolds DC; Relative risk factors in chronic open-angle glaucoma: an epidemiological study. *Am J Optom Physio*, 1977; 54:116-20.
5. Zeiter JH, Shin DH, Baek NH; Visual field defects in diabetic patients with primary open-angle glaucoma. *Am J Ophthal*, 1991; 111:581-584.
6. Le A, Mukesh BN, McCarty CA, Taylor HR; Risk factors associated with the incidence of open-angle glaucoma: the visual impairment project. *Invest. Ophthal Vis. Sci.*, 2003; 44:3783-789.
7. Schertzer RM, Wang D, Bartholomew LR; Diabetes mellitus and glaucoma. *Int Ophthal J*, 1998; 38:69-87.
8. Armstrong JR, Daily RK, Dobson HL; The incidence of glaucoma in diabetes mellitus: a comparison with the incidence of glaucoma in the general population. *Am J Ophthal*, 1960; 50:55-63.
9. Mitchell P, Smith W, Chey T; Open-angle glaucoma and diabetes: the Blue Mountains Eye Study *J Ophthal*, 1997;104:712-8.
10. Bonovas S, Peponis V, Filioussi K; Diabetes mellitus as a risk factor for primary open-angle glaucoma: a meta-analysis. *Diabet Med*, 2004; 21:609-614.
11. Casey PAN, Talwar N, Nan B, Musch T, Joshua D; The relationship between components of metabolic syndrome and Open-Angle Glaucoma. *J Ophthal*, 2011; 24:1188-1191.
12. Kellogs S; Diabetes and glaucoma a new prospective study. *J Ophthal care*, 2012; 7:112-121.

13. Tielsch JM, Katz J, Quigley HA, Javitt JC, Sommer A; Diabetes, intraocular pressure, and primary open-angle glaucoma in the Baltimore Eye Survey. *Ophthalmology*, 1995; 102:48–53.
14. Schertzer RM, Wang D, Bartholomew LR; Diabetes mellitus and glaucoma. *Int Ophthalmol Clin*, 1998; 38:69–87.
15. Hohl RD, Barnett DM; Diabetic hemorrhagic glaucoma. *Diabetes*, 1970;19:944–947.
16. Zirm M; Protein glaucoma—overtaxing of flow mechanisms? Preliminary report. *Ophthalmologica*, 1982;184: 155–161.
17. Sivak-Callcott JA, O'Day DM, Gass JDM, Tsai JC; Evidence-based recommendations for the diagnosis and treatment of neovascular glaucoma. *Ophthalmology*, 2007; 108:1767–1776.
18. Stamper RL, Lieberman MF, Drake MV; Optic disc changes in glaucoma. *Becker-Shaffers Diagnosis and Therapy of the Glaucoma*, 1999; 7:193-194.
19. Safir A, Paulsen EP, Klayman J, Gerstenfeld J; Ocular abnormalities in juvenile diabetics. Frequent occurrence of abnormally high tensions. *Arch Ophthalmol*, 1966; 76(4):557–562.
20. Jain I S, Gill M, Rastogi GK; Intraocular pressure in young diabetics and its relationship with diabetic retinopathy. *Indian J Ophthalmol*, 1969; 17:91-94.
21. Jain IS, Luthra CL; Diabetic retinopathy: Its relationship with intraocular pressure. *Archives of ophthalmology*, 1967; 78(2): 198-200.
22. Palomar-Palomar A; Manifestaciones oftalmológicas de la diabetes mellitus. *Arch Soc Oftalmol Hispano-Am*, 1956; 16: 827-1067.
23. Mitchell P, Smith W, Attebo K, Healey PR; Prevalence of open-angle glaucoma in Australia. The Blue Mountains Eye Study. *Ophthalmology*, 1996; 103(10): 1661-1669.
24. Chopra V, Varma R, Francis BA, Wu J, Torres M, Azen SP, et al.; Type 2 diabetes mellitus and the risk of open-angle glaucoma the Los Angeles Latino Eye Study. *Ophthalmology*, 2008; 115: 227–232.
25. Pasquale LR, Kang JH, Manson JE, Willett WC, Rosner BA, Hankinson SE; Prospective study of type 2 diabetes mellitus and risk of primary open-angle glaucoma in women. *Ophthalmology*, 2006;113: 1081–1086.
26. Dharmadhikari S, Lohiya K, Chelkar V, Kalyani VK, Dole K, Deshpande M, et al.; Magnitude and determinants of glaucoma in type II diabetics: A hospital based cross sectional study in Maharashtra, India. *Oman J Ophthalmol*, 2015;8 (1):19-23.
27. Klein BE, Klein R, Sponsel WE, Franke T, Cantor LB, Martone J, Menage MJ; Prevalence of glaucoma: the Beaver Dam Eye Study. *Ophthalmology*, 1992; 99:1499–1504.
28. Dielemans I, de Jong PT, Stolk R, Vingerling JR, Grobbee DE, Hofman A; Primary open angle glaucoma, intraocular pressure and Diabetes mellitus in the general elderly population: The Rotterdam Study. *Ophthalmology*, 1996; 103:1271-1275.
29. de Voogd S, Ikram MK, Wolfs RC, Jansonius NM, Witteman JC, Hofman A, de Jong PT; Is diabetes mellitus a risk factor for open-angle glaucoma? The Rotterdam Study. *Ophthalmology*, 2006; 113:1827–1831.
30. Ellis JD, Evans JM, Ruta DA, Baines PS, Leese G, MacDonald TM, Morris AD; Glaucoma incidence in an unselected cohort of diabetic patients: Is diabetes mellitus a risk factor for glaucoma? DARTS/MEMO collaboration. *Diabetes Audit and Research in Tayside Study. Medicines Monitoring Unit. Br J Ophthalmol*, 2000; 84:1218–1224.