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A Comparative Study of Serum Cholesterol and Triglyceride Levels in Cases of Primary Open Angle Glaucoma and In Normal Subjects

Dr.Prachi Dave[1], Dr.Ashok Kumar Meena[2],Dr.Jaishree Singh[3]
[1]*Resident doctor, Department of Ophthalmology, Government Medical College Kota, India*
[2]*Senior Professor and Head, Department of Ophthalmology, Government Medical College Kota, India*
[3] *Senior Professor, Department of Ophthalmology, Government Medical College Kota, India*

Abstract
Background: *Glaucoma is a leading cause of blindness worldwide. Intraocular pressure is the primary risk factor. But in spite of control of intraocular pressure, some cases progress which strengthens the view that there must be other independent risk factors in pathogenesis of glaucoma. Serums cholesterol and triglyceride have been found to be associated with glaucoma in few studies. We carried out the present study to study the relation between serum cholesterol and triglyceride in cases of Primary Open Angle Glaucoma (POAG) and in normal subjects.*
Materials and Methods: *This study was conducted on 30 patients with POAG (cases) and 35 individuals without glaucoma (controls). Ophthalmic examination was performed in all the patients and fasting lipid profile including serum total cholesterol, serum triglycerides, serum LDL cholesterol, serum VLDL cholesterol and serum HDL cholesterol were measured and analysed between the cases and controls using enzymatic colorimetric method.*
Results: *Results obtained showed that there is significant relationship between high serum total cholesterol, serum triglycerides, serum LDL cholesterol, serum VLDL cholesterol to POAG with p value < 0.05. Level of HDL was higher in cases than in controls and was statistically significant, hence no protective role of serum HDL was found in our study.*
Conclusion: *Dyslipidemia is an independent risk factor for POAG. High serum cholesterol, high serum triglycerides and high serum LDL and VLDL correlate significantly with POAG. Thus, treatment of deranged lipid profile can provide a potential preventing strategy for Primary Open Angle Glaucoma (POAG).*
Key Words: *Primary open angle glaucoma, Lipids, Dyslipidemia, Correlation*

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I. Introduction

Blindness is the most dreadful assumption of human beings which not only makes the life miserable but also leaves the patient as a liability to family. Glaucoma is the second leading cause of blindness worldwide, globally POAG affects more people than angle closure glaucoma (ACG)-with an approximate ratio of 3:1, and wide variations among populations. **Quigley et.al.**[1] estimated that by 2020 there will be approximately 80 million people with glaucoma, an increase of about 20 million since 2010 of which 74% will have primary open angle glaucoma. The number of glaucoma cases globally by 2040 will be around 111.8 million. Furthermore, it is thought that at present over 3 million people are blind, a figure that is set to rise to 3.2 million by 2020 with increasing prevalence, unless improved screening and effective treatment strategies are successful. In India, the prevalence of POAG is higher than PACG[2]. Around 12 million people suffer from glaucoma ;1.5 million are blind due to glaucoma, predominantly due to PACG though it is less common[3] making the third most common cause of irreversible blindness. Many population based surveys were conducted in India to assess the magnitude of glaucoma[4] .The prevalence of glaucoma ranged from 6.9% to 8.1% among the age group of 40 years and above[5,6].In addition, aging is closely associated with glaucoma, therefore , considering the fast pace of demographic transition observed in India, the number of people affected with glaucoma will be increased over time. The irreversible and relatively asymptomatic nature of damage caused by glaucoma makes it a great public challenge than cataract, which is the leading cause of blindness globally. In recent years glaucoma has come to forefront as an important ocular disease. The increase in the incidence of glaucoma could indirectly be due to higher longevity of people in this era. Primary open angle glaucoma (POAG) can be considered a chronic, progressive, anterior optic neuropathy that is accompanied by a characteristic cupping and atrophy of the optic disc, visual field loss, open angles and no obvious causative ocular or systemic condition. The disease,

particularly during initial stages is asymptomatic and it has been said that half of the people who suffer from disease are unaware of occurrence. However, they gradually develop signs, such as increased intraocular pressure, cupping of optic disc and distortion of visual field. A link between glaucoma and serum lipids has long been suspected and various studies have revealed variable association between the two. High lipid levels cause atherosclerotic changes leading to Hypertension. Thus there is possibility that glaucoma is indirectly related to serum lipid levels[7].Lipid peroxidation leading to oxidative stress may directly damage trabecular meshwork and endothelium of blood vessels supplying optic nerve head or atherosclerotic changes due to high cholesterol level may affect ocular perfusion[8].However, the exact mechanisms explaining how hyperlipidemia could increase risk of progression of glaucoma is unclear, one possible explanation might be that excess blood lipid levels would increase the episcleral venous pressure and blood viscosity, resulting in consequent decrease in outflow facility. Hence, this study has been undertaken to throw some more light on the association as this would help in better understanding the pathogenesis of primary open angle glaucoma and it's association with levels of serum cholesterol and triglyceride, it's treatment and management.

II. Materials And Method

This cross-sectional study was conducted in the Department of Ophthalmology at GOVERNMENT MEDICAL COLLEGE, KOTA and attached group of hospitals from May 2019 to May 2020. Study was conducted on 65 patients (30 patients of POAG and 35 healthy volunteers) over 35 years of age.

Inclusion criteria: Subjects above age of 35 years, physically and mentally fit subjects capable of giving voluntarily informed consent.

Exclusion criteria: Subjects with age below 35 years, other causes of glaucoma like primary angle closure glaucoma, secondary glaucoma, pre-existing ocular disease, history of trauma or any ocular surgery prior to occurrence of glaucoma in eye and patients with high myopia, known case of diabetes mellitus, hypertension and thyroid disease were excluded from study.

Study subjects were classified into two groups-

GROUP A- This group included individuals having no glaucoma, but attends eye department for defective vision.

GROUP B-Cases of primary open angle glaucoma.

Written informed consent was taken from all the subjects. Demographic data including age, gender, address were noted. Ophthalmic examination was performed like visual acuity using Snellen's chart, Anterior segment examination, slit lamp examination, pupillary reactions, intraocular pressure measurement using Schiotz tonometer was done. Gonioscopy was done to evaluate the angle structures. Fundus examination and visual field analysis were done. Primary open angle glaucoma was diagnosed on the basis of raised IOP, optic nerve head changes detected by direct ophthalmoscopy and visual field defects. Twelve hour fasting blood samples were collected for measuring serum lipids and assessed using enzymatic method (autoanalyzer). The lipid profile included total cholesterol, triglycerides (TGL), Low Density Lipoproteins (LDL) and High Density Lipoproteins (HDL).Reference values for lipids were taken from **National Cholesterol Education Program: Adult Treatment Panel III (NCEP: ATP III) guidelines**, according to which Hypercholesterolemia is defined as total cholesterol > 200 mg/dl, Hypertriglyceridemia, when triglycerides > 150 mg/dl, LDL > 130 mg/dl were considered high and HDL < 40 mg/dl were considered low. Mean, Standard deviation and standard error of means were calculated. Statistical analysis was performed. P value < 0.05 was considered significant and p value <0.001 was considered highly significant.

III. Results

Table 1: Demographic parameters of study population

PARAMETER	**CASES(n=30)**	**CONTROL GROUP(n=35)**
MEAN AGE (years)	57.8±10.8	57.91±5.59
GENDER (Male:Female)	14:16	15:20
LOCALITY	16/30 URBAN (53.33%)	22/35 URBAN (62.85%)
OBESITY	6/30 (20%)	2/35 (5.71%)
FAMILY HISTORY OF GLAUCOMA	10/30 (33.33%)	8/35 (22.85%)
AVERAGE DURATION OF GLAUCOMA (in years)	5.75	-

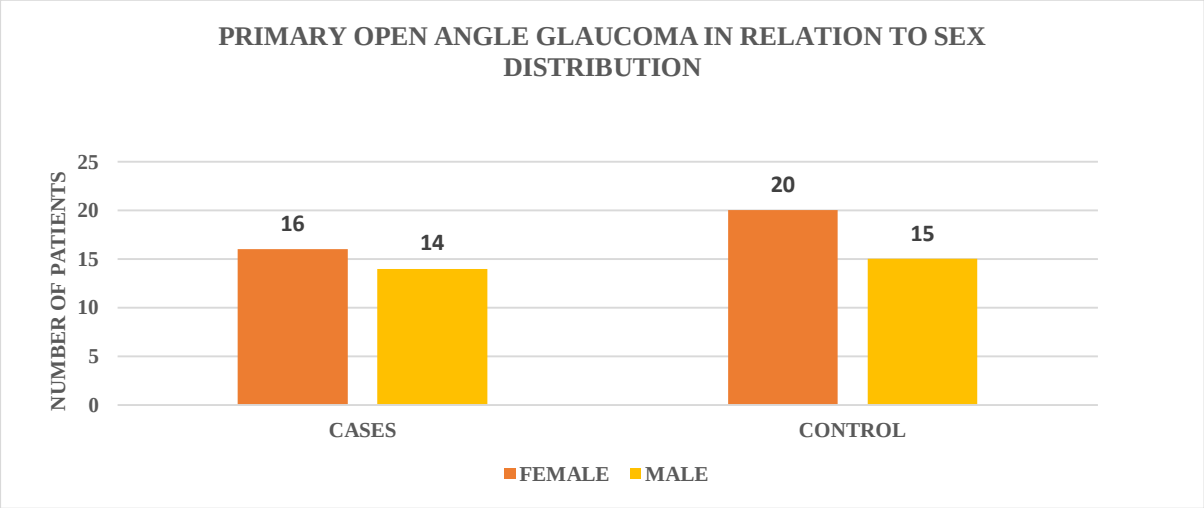

Table 1 shows that the age of patients ranged from 37 to 74 years with a mean of 58 years (cases) and 58 years (control). The male to female ratio was 14:16 in cases and 15:20 in controls. 16 out of 30 (53.33%) cases and 22 out of 35 controls (62.85%) were from urban background whereas 14 out of 30 (46.67%) of the POAG cases and 13 out of 35 (37.14%) controls were from rural areas.10 out of 30 cases (33.33%) and 8 out of 35 controls (22.85%) had a positive family history of glaucoma.6 out of 30 (20%) cases and 2 out of 35 controls (5.71%) were overweight or obese. Average duration of glaucoma in cases being 5.75 years (ranging from recently diagnosed to 15 years).

Table 2: Deranged lipid profile in cases and control group

LIPID PARAMETERS	**CASES(n=30)**	**CONTROL GROUP(n=35)**
High Serum Total Cholesterol (>200 mg/dl)	19/30 (63.33%)	0/35 (0%)
High Serum Triglyceride (>150 mg/dl)	18/30 (60%)	3/35 (8.58%)
High Serum LDL (>130 mg/dl)	9/30 (30%)	0/35 (0%)
Low Serum HDL (<40 mg/dl)	1/30 (3.33%)	6/35(17.14%)
High Serum VLDL (>30 mg/dl)	17/30 (56.67%)	4/35 (11.42%)

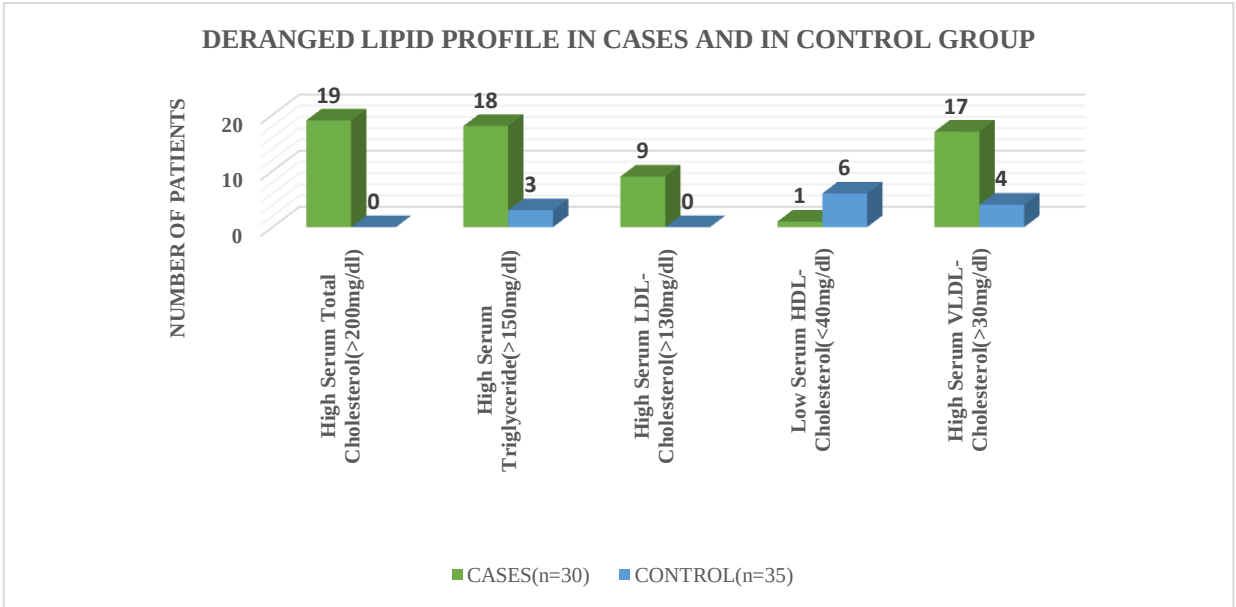

Table 2 shows that high Serum Total Cholesterol (>200mg/dl) was seen in 19 cases, whereas in controls none of individuals have high cholesterol. High Serum Triglycerides (>150mg/dl) was seen in 18 cases

whereas 3 controls have high triglycerides. Serum LDL-Cholesterol was high (> 130 mg/dl) in 9 cases and 0 controls. Serum HDL-Cholesterol was low (< 40mg/dl) in 1 case and 6 controls. Serum VLDL-Cholesterol was high (> 30 mg/dl) in 17cases and 4 controls.

Table 3: Serum lipid values in cases and control group

PARAMETERS	CASES(n=30)	CONTROL GROUP(n=35)	P value
Mean cholesterol (mg/dl)	205.9±44.85	158.97±10.65	<0.0001
Mean triglyceride (mg/dl)	173.13±88.79	114.97±22.32	=0.0004
Mean LDL (mg/dl)	113.26±37.69	89.71±12.87	=0.0009
Mean HDL (mg/dl)	57.9±13.58	45.38±6.79	<0.0001
Mean VLDL (mg/dl)	34.56±18.18	23.11±4.57	=0.0006

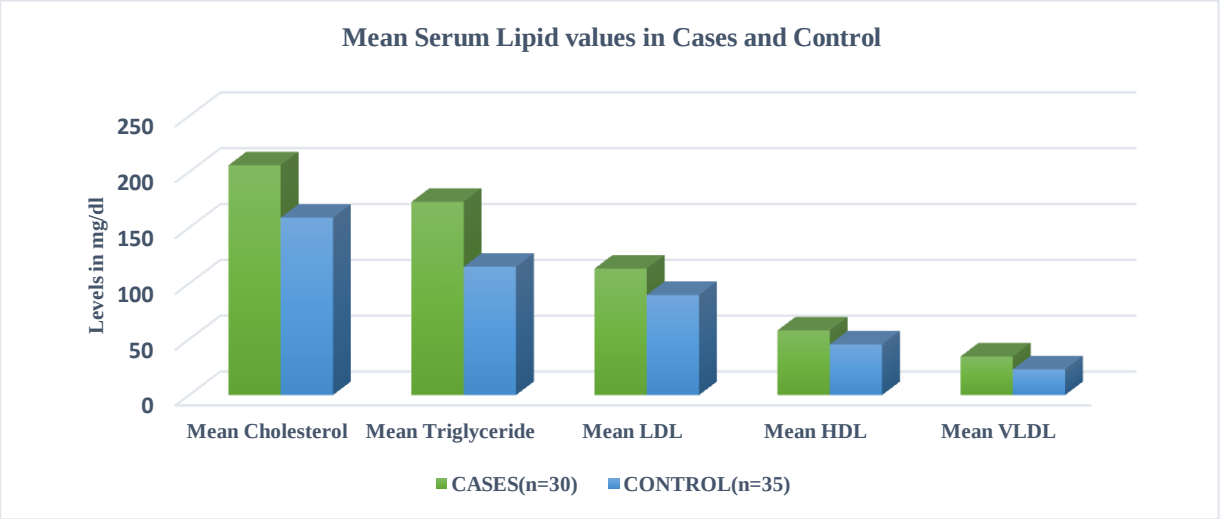

Table 3 shows that in cases, mean total cholesterol was 205.9 +/- 44.85 mg/dl; mean triglycerides was 173.13+/- 88.79 mg/dl; mean LDL level was 113.26+/- 37.69 mg/dl and mean HDL was 57.9 +/- 13.58 mg/dl; mean VLDL level was 34.56+/-18.18 mg/dl. In controls, mean total cholesterol was 158.97 +/- 10.65 mg/dl; mean triglycerides was 114.97 +/- 22.32 mg/dl; mean LDL level was 89.71 +/- 12.87 mg/dl and mean HDL was 45.38 +/- 6.79 mg/dl; mean VLDL level was 23.11+/-4.57 mg/dl .As depicted in table, level of total cholesterol, total triglycerides, LDL cholesterol and VLDL- cholesterol were significantly higher in cases than in controls with p value < 0.05 taking confidence interval 95%.

IV. Discussion

A total of 65 patients were included in study which were then divided into 2 groups – group A which included 35 patients (control group i.e. individual having no glaucoma but attends eye department for defective vision) and group B (cases of primary open angle glaucoma) which included 30 patients and an attempt was made to study correlation between serum cholesterol and triglyceride levels in two groups.

The results obtained showed that there is a significant relationship between high cholesterol, LDL, and triglyceride and VLDL to POAG. HDL was found to be higher in cases than controls, hence no protective role of HDL- Cholesterol is seen in our study.

Kovacevic et al[9] concluded in their study that patients with higher values of total cholesterol, particularly atherogenic LDL fraction, may have certain influence in glaucoma. Serum lipid values were similar in both groups for triglycerides, HDL and LDL lipoproteins but cholesterol values were significantly higher in the POAG group.

Egorowetal[10] showed that lipid biochemical analysis in patients with glaucoma may have atherogenic hyperlipidaemia with lower antioxidative activity. The statins in usage longer than 23 months may significantly reduce the risk of glaucoma [11].Therefore, the statins usage in hyperlipidaemia therapy could not change intraocular pressure values in patients with glaucoma but could reduce the risk of glaucoma.

In a case control study conducted by **Davari et al**[12], there was a positive association between POAG and dyslipidemia (OR=7.14 [95% CI: 2.3-22.2] for Hypercholesterolemia and OR=16.9 [95% CI: 2.1-14.8] for hypertriglyceridemia. Conclusion was drawn that hyperlipidemia can be a risk factor for POAG.

In a similar study in 2009, by **Pavljasevic and Asceric**[13] in Bosnia and Herzegovina, the researchers tested 50 patients with open-angle glaucoma and 50 healthy individuals with respect to their serum lipids. The cholesterol mean value in the test group was 6.14 mol/dm whereas in the control group it was 5.96 mol/dm. The triglyceride mean value in the test group was 2.38 mol/dm and in the control group it was 2.04 mol/dm. High density cholesterol was average in the test group with 1.45 mol/dm and in the control group 1.40 mol/m. Low density cholesterol in the test group was 3,98 mol/m and in the control group 4.08 mol/m. This means that blood cholesterol levels for patients in the test group were higher compared to those of the control group and could suggest that hypercholesterolemia could be one of predictable factor in POAG diagnosis.

In the **Beijing eye study**[14], about 3251 individuals (age>45 years) had their complete ophthalmic examination. Blood serum lipids were also measured. After adjustment of various factors (such as age, sex, residence, income level, BMI, cigarette smoking, diastolic blood pressure, and blood sugar) the effect of dyslipidemia on the incidence of ophthalmic diseases was studied. Results showed in dyslipidemic patients, IOP was significantly increased.

In a study done by **Chisholm and Stead**[15] in1988 on 183 patients (92 women and 91 men) with glaucoma, with the aim of surveying serum lipid levels, it was found that only triglycerides in female adults was significantly high.

In a study by **Stewart et al**[16] in 1996, a comparison was made between total cholesterol and HDL of 25 glaucoma patients and 25 healthy individuals, which showed that there is no relationship between HDL and total cholesterol to IOP or POAG.

Maybe, the relationship between lipids and glaucoma is due to the association of this disorder with other cardiac risk factors such as diabetes and hypertension. In a study conducted in **Michigan university** people aged >40 years who had one or more ophthalmic visit were included in a cohort study (2001-2007). The aim of this study was to assess the elements of metabolic syndrome and glaucoma. The results showed that diabetes and hypertension proper or associated with each other have a role in occurrence of glaucoma but dyslipidemia alone even lowered the risk of glaucoma by about 5%. However, in cases that dyslipidemia is associated with diabetes or hypertension the risk increases[17].These results points to a combined effect of dyslipidemia with hypertension or diabetes in pathogenesis of glaucoma. In our study we find that dyslipidemia is an independent risk factor for glaucoma after removing these confounding factors.

These studies will help us in understanding the mechanisms by which dyslipidemia leads to development of POAG. Various studies showing increased levels of lipid peroxides in the aqueous humor, trabecular meshwork and Schlemm's canal in POAG cases compared with control eyes suggest that lipid peroxidation by increasing oxidative stress is responsible for destruction of the trabecular meshwork and Schlemm's canal[18-20].

V. Conclusion

Our study was a hospital based study and consisted of a small group of people which demonstrated an association between serum lipid and cholesterol levels and primary open angle glaucoma. We observed that elevated serum cholesterol and triglyceride levels is an independent risk factor for POAG. High serum cholesterol, high serum triglycerides and high serum LDL and VLDL correlate significantly with POAG. No significant relation was found between primary open angle glaucoma with sex, residential type and risk factors such as obesity and family history of glaucoma. Thus, treatment of deranged lipid profile can provide a potential preventing strategy for primary open angle glaucoma (POAG).

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