# Predicting Chances Of Developing Glaucoma In Untreated Ocular Hypertensive Patients

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***Abstract:***
***Background:*** *Ocular hypertension (OHT) is a condition where Intraocular Pressure (IOP) is high with no evidence of glaucomatous optic nerve damage or visual field loss. Treatment decisions will rely on patient's risk of developing primary open angle glaucoma (POAG) weighed against potential adverse effects, cost and life expectancy. Therefore, in untreated ocular hypertensive patients, validated risk estimators become useful tools in predicting chances of developing POAG. The data on Indian population is lacking hence, we designed this study to predict chances of developing glaucoma in untreated ocular hypertensive patients using glaucoma 5-year risk estimator.*
***Methodology:*** *This observational study was conducted in department of ophthalmology in patients with intraocular pressure between 24-32 mm Hg in one eye and 21-32 mm Hg in other eye with no optic nerve damage or loss of visual function. A total of 20 patients were enrolled in study, which gave written informed consent and fulfilled the inclusion and exclusion criteria.*
***Results:*** *Increased age, intraocular pressure, vertical cup-disc ratio, pattern standard deviation in visual fields and decreased central corneal thickness were significantly related to increased chances of developing glaucoma making the glaucoma 5-year risk estimator a useful tool in predicting chances of developing glaucoma in untreated ocular hypertensive patients.*
***Conclusions:*** *Glaucoma 5-year risk estimator is useful tool in predicting chances of developing glaucoma in untreated ocular hypertensives in next five years, based on five parameters- age, intraocular pressure, central corneal thickness, vertical cup disc ratio by contour and pattern standard deviation in visual fields.*
***Keywords****: intraocular pressure, ocular hypertension, glaucoma, untreated*

## I.    Introduction

Glaucoma is an ocular disorder of multifactorial etiology characterized by optic neuropathy with optic nerve head (ONH), visual field changes or both and is second leading cause of global blindness after cataract [1]. Glaucoma is further classified according to anterior chamber angle findings and presence or absence of disease states causing elevated IOP [2], if no cause can be discerned to a rise in intraocular pressure it is called primary glaucoma. The rise in intraocular pressure secondary to other ocular/ systemic disease or drug use is called secondary glaucoma. Glaucoma can further be divided into open angle glaucoma and angle-closure glaucoma on the basis of anterior chamber angle findings [3]. Ocular Hypertensive study (OHTS) defines OHT as a condition in which intraocular pressure (IOP) is between 24-32 mm Hg in one eye and 21-32 mm Hg in the other eye with no evidence of glaucomatous damage. Since the individuals with ocular hypertension are more susceptible for development of primary open angle glaucoma (POAG) as compared to normal subjects, early diagnosis and initiation of ocular hypotensive medication in high-risk group may reduce the incidence of POAG and subsequent visual disability [4].

The Ocular Hypertension Treatment Study (OHTS) demonstrated that a 20 percent reduction in IOP reduced the incidence of POAG by more than 50 percent. However, the treatment of all ocular hypertensive individuals is neither medically indicated nor economically justified because of the cost, non-compliance and possible adverse effects of treatment [4]. Therefore in OHT, predictive models or risk estimators may benefit clinicians in providing a more objective assessment of risk and can guide management. In one study, Boland and colleagues demonstrated that the use of a risk calculator changed recommendations prescribed by clinicians and increased the measure of confidence in their recommendations [5-8].

Steve Mansberger using information from OHTS, with a formula similar to the Framingham Heart Study, developed the first of the risk calculators. Medeiros and Weinreb were involved in the next version of the risk assessment tool, which became known as the STAR (Scoring Tool to Assess Risk) calculator [5-8]. The most recent calculator known as Glaucoma 5-Year Risk Estimator is based upon the OHTS data using the placebo arm of the European Glaucoma Prevention Study (EGPS) as the validation set [9]. Since, the data on Indian population is lacking so we have devised this study to predict the chances of developing glaucoma in untreated ocular hypertensive patients using glaucoma 5-year risk calculator.

## II.     Materials and methods:

This observational study was conducted in Department of Ophthalmology. Twenty patients visiting Government Medical College and Rajindra Hospital Patiala in a period of 5 months from November 2016 to March 2017 with Intraocular pressure between 24-32 mm Hg in one eye and 21-32 mm Hg in other eye with no optic nerve damage or loss of visual function were included in this study. The Institutional Ethics Committee approved the study and only those patients who gave written informed consent were included in the study.

Both males and females in the age group of 30-80 years, with best-corrected visual acuity tested by ETDRS more than 20/40, gonioscopically open angles and willing to give written informed consent were included in the study. Patients with previous intraocular surgery (other than uncomplicated cataract extraction with posterior chamber lens implantation), systemic/topical steroid use, patients already diagnosed with glaucoma, patients already undergoing treatment with ocular hypotensive drugs/modalities, secondary causes of elevated IOP, angle-closure glaucoma or anatomically narrow angles as well as other ocular diseases that can cause visual field loss were excluded from the trial. Preexisting glaucomatous optic nerve damage, defined as optic disc hemorrhage, a localized optic disc notch or thinning of the rim, a localized area of pallor, and/or an asymmetry of cup/disc ratios by > 0.2 between both eyes, were also excluded. Both eyes had to meet the eligibility criteria. Patient enrolled in the study then underwent Glaucoma 5-year risk estimator [9].
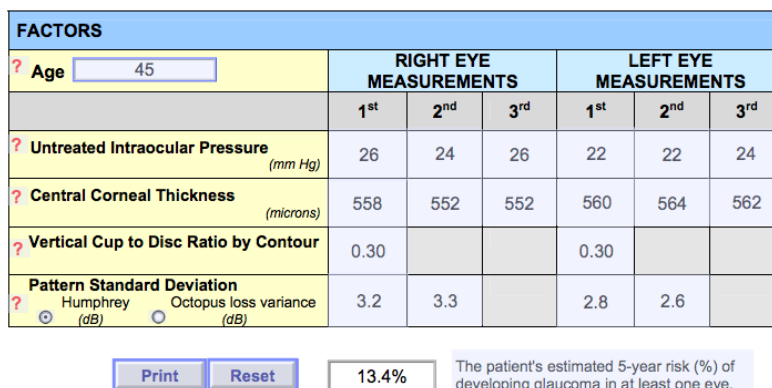
**Parameter Used:**

Glaucoma 5-year risk Estimator requires age of patient in years, patients were then subjected to detailed ocular examination such as ETDRS visual acuity testing, fundus examination using 90D Slit-lamp bimicroscopy (vertical cup/disc ratio by contour - 1 measurement per eye), gonioscopy using indirect goldmann goniolens to rule out angle closure, IOP (3 measurements per eye measured using Goldmann applanation tonometry), central corneal thickness using an ultrasound pachymeter (3 measurements per eye) and pattern standard deviation (2 measurements per eye) either using humphrey full threshold 30-2 or 24-2, SITA standard 30-2 or 24-2 or loss variance from Octopus 32-2. It adds to the quality of clinical care as one consensus group suggested observing low-risk patients, considering treatment for moderate risk patients, and treating those at highest risk. The exact treatment threshold has not been clearly determined but chances <5% are considered as low risk, 5-15% as moderate risk, and >15% as high risk. However, the risk estimator should be used as an adjunct to, and not as a substitute for, clinical experience and judgment as other factors such as patient's overall health status, life expectancy and commitment to treatment should also be weighed against potential adverse events and cost of treatment [9].

Two methods can be used to estimate the 5-year risk of developing POAG:

1. The Continuous Method: The actual data for the patient age and eye measurements are entered.

2. The Point System: The range for the patient age and average of the multiple measurements are entered.

For our study continuous method was used and recorded readings were inserted in the estimator [9] and the chances are calculated, as exemplified in Figure 1.

**Figure 1.** Continuous method to estimate the 5-year risk of developing POAG



| FACTORS | RIGHT EYE MEASUREMENTS | | | LEFT EYE MEASUREMENTS | | |
|---|---|---|---|---|---|---|
| Age: 45 | 1st | 2nd | 3rd | 1st | 2nd | 3rd |
| Untreated Intraocular Pressure *(mm Hg)* | 26 | 24 | 26 | 22 | 22 | 24 |
| Central Corneal Thickness *(microns)* | 558 | 552 | 552 | 560 | 564 | 562 |
| Vertical Cup to Disc Ratio by Contour | 0.30 | | | 0.30 | | |
| Pattern Standard Deviation (Humphrey *(dB)* / Octopus loss variance *(dB)*) | 3.2 | 3.3 | | 2.8 | 2.6 | |

Print | Reset | 13.4% | The patient's estimated 5-year risk (%) of developing glaucoma in at least one eye.

**Statistical analysis:** SPSS (Statistical package for social sciences) version 21.0 was the software that was used for testing of data and hypotheses. The data was tabulated as mean ± standard deviation (SD). The 5-year risk for developing glaucoma was expressed as percentage chance. Result was analyzed using correlation (Pearson correlation coefficients) analysis. A $p < 0.05$ was considered statistically significant.

## III.     Result

A total of 20 patients who fulfilled the inclusion and exclusion criteria participated in the study, with equal number of males and females. The mean age of patients was 56.65±12.53 years (Range from 32 - 79 years). All patients underwent fundus examination using 90D Slit-lamp bimicroscopy (vertical cup/disc ratio by contour - 1 measurement per eye), gonioscopy using indirect goldmann goniolens to rule out angle closure, IOP (3 measurements per eye measured using Goldmann applanation tonometry), central corneal thickness using an ultrasound pachymeter (3 measurements per eye) and pattern standard deviation (2 measurements per eye) for both eyes in shown in Table 1.

**Table 1**. Demographic characteristic (Mean ±SD) of patients:

| Parameter | Right Eye | Left Eye |
|---|---|---|
| Intraocular Pressure (mm of Hg) | 25.90±3.12 | 26.57±3.28 |
| Central Corneal Thickness (Micron) | 566.48±14.24 | 565.71±15.18 |
| Vertical Cup to Disc Ratio by Contour | 0.44±0.13 | 0.40±0.09 |
| Pattern Standard Deviation – Humphrey (dB) | 1.71±0.71 | 1.92±0.64 |

The range for intraocular pressure varied from 22-32 in right eye and 22-32 in the left eye. The range of Central corneal thicknesses varied from 540-591 in right eye and 538-592 in left eye. The range of vertical cup to disc ratio by contour varied from 0.3 to 0.7 in both eyes. The range of pattern standard deviation-Humphrey varied from 0.7 to 3.1 in right eye and 0.8 to 3.0 in left eye.

**Percentage Chance of developing glaucoma**

Percentage chance of developing glaucoma in one eye in 5 years in shown in Figure 2 with mean percentage chance was found to be 14.62±14.75%. The percentage chance for developing glaucoma in at least one eye over a period of 5 years was from 3.5-57.9%.

**Figure 2**. Percentage chance for developing glaucoma
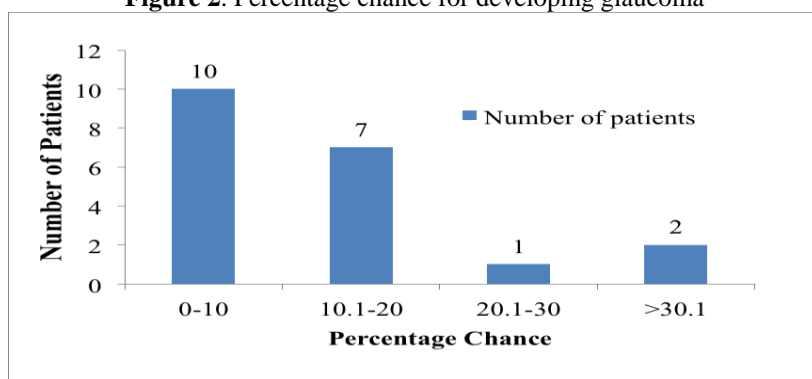


## IV.     Correlation

Estimates of correlation for percentage chance of developing glaucoma in at least one eye in five years with various parameters was calculated and it was seen that all parameters had statistically significant ($p > 0.05$) correlation with the percentage chance of developing glaucoma (Table 2).

**Table 2.** Correlation coefficients for percentage chance of developing glaucoma with various parameters among patients in both eyes

| Variables | Percentage Chance | | | |
|---|---|---|---|---|
| | Right Eye (n=20) | | Left Eye (n=20) | |
| | r | p | r | p |
| Age (in years) | 0.61 | | <0.05 | |
| Intraocular Pressure (mm of Hg) | 0.74 | <0.05 | 0.46 | <0.05 |
| Central Corneal Thickness (Micron) | -0.45 | <0.05 | -0.53 | <0.05 |
| Vertical Cup to Disc Ratio by Contour | 0.46 | <0.05 | 0.49 | <0.05 |
| Pattern Standard Deviation – Humphrey (dB) | 0.59 | <0.05 | 0.53 | <0.05 |

## V. Discussion

Several studies have established that the untreated ocular hypertensive patients have higher risk of developing POAG in coming years based on risk factors present. Since, treatment of all ocular hypertensive patients is neither feasible, nor recommended; glaucoma risk estimators become useful tool in scrutinizing high-risk patients from low-risk patients [9]. The objective of our study was to predict chances of developing glaucoma in untreated ocular hypertensive patients using glaucoma 5-year risk estimator. The results of our study found that increased age, intraocular pressure, vertical cup-disc ratio, pattern standard deviation in visual fields and decreased central corneal thickness were significantly related to increased chances of developing glaucoma.

In one study, Mansberger *et al.* performed a survey of ophthalmologists to estimate their ability to predict the risk of glaucoma development in ocular hypertensive patients. It was found that ophthalmologists tended to underestimate the risk when compared to the actual risk found by a risk calculator. It was also seen that ophthalmologists had a large range of predictions, sometimes differing from the actual risk by 40%, illustrating the need for a more standardized method for risk assessment [10].

OHTS validated traditional risk factors such as higher IOP and older age associated with higher rates of developing glaucoma. Patients with larger cup-to-disc ratios (greater than 0.5) and pattern standard deviation were also at a higher risk for developing glaucoma [11].

OHTS also established central corneal thickness as important factor in determining a given patient's 5-year risk of developing glaucoma. It was seen that patients with thinner corneas were at greater risk. As seen in study, patients with a central corneal thickness of less than 555 μm and a baseline IOP of greater than 25.75 mm Hg had a 5-year risk of 36%, while patients with central corneal thickness greater than 588 μm but other similar variables had only 6% 5-year risk of developing glaucoma. [11]

All these results are consistent with our study, emphasizing the role of glaucoma risk estimator in untreated ocular hypertensive patients.

Medeiros FA, et.al. in 2009 analyzed the data pool of OHTS and EGPS and concluded that only 5 baseline factors to be significantly associated with the risk of converting to glaucoma: age, intraocular pressure, central corneal thickness, the measurement of the vertical cup/disc ratio of the optic nerve and the visual field index pattern standard deviation (PSD). Our study not only validated these findings but also utilized these risks factors in predicting the chances of developing glaucoma which was lacking in the study [5].

However, there are certain limitations to estimator such as the testing protocols of patients should resemble patient pool of OHTS and EGPS as well as it is not clear that whether these models also predict progression of established disease or not? [9]

## VI. Conclusion

Glaucoma 5-year risk estimator is useful tool in predicting the chances of developing glaucoma in untreated ocular hypertensive in next five years. Increased age, intraocular pressure, vertical cup-disc ratio, pattern standard deviation in visual fields and decreased central corneal thickness are significantly related to increased chances of developing glaucoma in such patients.

## Acknowledgements

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