Original Article

# Study of the influence of gender and blood pressure on intraocular pressure in South Indian population

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## Abstract

**Background and Aim:** Glaucoma is the second most common cause of blindness and visual impairment worldwide, and increased intraocular pressure (IOP) is considered as an important risk factor. Recently, the blood pressure (BP) has been identified as a modifiable risk factor for the genesis of glaucoma. Therefore, the present work was conducted to assess the relationship between IOP and BP and the gender difference in IOP.

**Methods:** A total of 180 subjects aged between 30 and 60 years attending the outpatient department of Ophthalmology and Medicine of A.J Institute of Medical Sciences, Mangalore were recruited for the study. BP was recorded in supine position, and IOP was recorded using Schiotz tonometer.

**Results:** All the values were expressed as mean and standard deviation. $P$ <0.05 was considered statistically significant. IOP was higher in women compared to men. Systolic BP and diastolic BP were positively correlated with IOP.

**Conclusion:** Increase in BP increases the IOP, and subjects with hypertension are at increased risk for genesis of ocular hypertension. Thus, a population-based screening for raised IOP can reduce the prevalence of glaucoma, especially in hypertensive subjects.

**Key words:** Age, blood pressure, intraocular pressure

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## INTRODUCTION

Intraocular pressure (IOP) is the pressure exerted by the intraocular fluids on the coats of eyeball.[1] In the healthy eye, flow of aqueous humor against resistance generates an IOP, which is necessary for the proper shape and optical properties of the globe.[2] Glaucoma is defined as a disturbance in the structural or functional integrity of the optic nerve that can usually be arrested or diminished by adequate lowering of IOP.[3] Asymptomatic in its earlier stages, the disease is nevertheless one of the leading global causes of irreversible blindness.[4] Although IOP remains an important risk factor for glaucoma, other factors can also influence the disease development and progression.[5] Several studies have implicated vascular risk factors in the pathogenesis of glaucoma. Among them, blood pressure (BP) has become increasingly important.[6] Recently, the role of BP in the genesis of glaucoma has been identified as one of the modifiable risk factors. Hence, screening of IOP is of utmost importance in patients with hypertension as it helps prevent glaucoma, which is the second most common cause of blindness and visual impairment worldwide. Thus, a population-based screening for raised IOP can reduce the prevalence of glaucoma, which has been recognized as a major cause of blindness worldwide. Therefore, in the present study, we have planned to study the relationship between IOP and BP, and the effect of gender on IOP.

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## MATERIALS AND METHODS

A total of 180 subjects aged between 30 and 60 years attending the outpatient department (OPD) of Ophthalmology and Medicine of A.J Institute of Medical Sciences, Mangalore were recruited for the study. Of 180 subjects, 94 were males and 86 were females. The study period was from February 2011 to February 2012. Ethical clearance was obtained from Institute's Ethical Committee prior to the commencement of the study. Newly diagnosed hypertensives aged between 30 and 60 years and not on any antihypertensive medication were included in the study. Subjects <30 years and >60 years of age, previously diagnosed hypertensives and on antihypertensive medication, subjects with history of glaucoma, blind subjects, subjects with history of ocular surgery, diabetes, renal, endocrine, cardiovascular diseases, and any other chronic illness were excluded from the study. Written informed consent was obtained from the subjects prior to the onset of the study. The procedure of the study was explained in detail, and the subjects were also informed that the study was purely noninvasive.

Detailed history about the name of the subject, age, occupation, and personal history was obtained. Any family history of hypertension, diabetes, refractive errors, and glaucoma was enquired. BP was recorded in the right upper limb of the subjects in supine posture by both palpatory and auscultatory method using a mercury sphygmomanometer. Then, IOP of the subject was measured as mentioned below.

### Procedure of recording the intraocular pressure

The IOP was recorded using Schiotz indentation tonometer in ophthalmology OPD. Before recording the IOP, each time the instrument was calibrated by placing it on a polished metal sphere and the scale reading was made to coincide at zero. Subjects were explained about the procedure and were re-assured that the procedure was painless. The subjects were made to lie down in supine position and asked to look straight upward on the ceiling with gaze fixed. During the procedure, the subjects were asked to relax and breathe normally and keep their eyes wide open without blinking. Cornea was anesthetized with 2–3 drops of 4% topical lignocaine. The tonometer tip and footplate were wiped with an alcohol swab and allowed to air dry. Eyelid of the subject was retracted gently with left hand without placing tension on the globe. By holding the handle of the tonometer with right hand, the footplate of the tonometer was lowered gently onto the cornea. The handle of the tonometer was lowered to a position midway between the top and the footplate of the cylinder; thereby, the instrument will act independently by its own weight. Once the needle became steady, the reading on the scale was recorded. Until we got three consecutive readings within the range of 0.5 units, IOP measurement was repeated. The average of the scale reading and the plunger weight were then converted into IOP in mmHg using a conversion chart Friedenwald nomogram.

The tonometer plunger and footplate were rinsed with water after every use, followed by alcohol, and then made dry. Ciprofloxacin eye drop was instilled prophylactically in both the eyes to prevent any ocular infections after the procedure.

### Statistical analysis of data

Data were expressed as mean, standard deviation, and range. Student's unpaired *t*-test was used for comparing the mean of male and female groups. One-way ANOVA was used to assess the variation in IOP with BP. Pearson's correlation and regression analysis were performed to assess the relationship between IOP and BP. $P \leq 0.05$ was considered statistically significant.

## RESULTS

Table 1 depicts the gender difference in IOP. The mean IOP was higher among women (16.35 mmHg) when compared to men (16.13 mmHg), but the difference was not statistically significant ($P > 0.05$).

Table 2 depicts the relationship between IOP and systolic BP (SBP). IOP was higher in subjects with increased SBP (120–130 mmHg group and 131–140 mmHg group) compared to subjects with BP <120 mmHg.

Table 3 depicts the relationship between IOP and diastolic pressure. IOP increases with increase in diastolic BP (DBP) (81–90 mmHg group and 91–100 mmHg group) compared to subjects with BP <80 mmHg.

Table 4 depicts the correlation between IOP, SBP, and DBP. Correlation analysis was performed to assess the relationship between SBP and IOP ($r = +0.317$) and the relationship was statistically significant ($P < 0.05$) [Table 2]. By correlation analysis study, the subject's IOP can be predicted by their SBP using the formula: IOP in mmHg = 9.88 + 0.049 (SBP). Correlation analysis was performed to assess the relationship between DBP and IOP ($r = +0.265$) and the relationship was statistically significant ($P < 0.05$) [Table 2]. By correlation analysis study, the subject's IOP can be predicted by their DBP using the formula: IOP in mmHg = 10.90 + 0.063 (DBP).

**Table 1:** Comparison of IOP between men and women

| Sex | Number of subjects | IOP (mmHg) | | *P* |
|---|---|---|---|---|
| | | Mean | SD | |
| Males | 94 | 16.13 | 2.35 | 0.514 |
| Females | 86 | 16.35 | 2.15 | |

Statistical analysis of data was done using independent Student's *t*-test and *P*>0.05 was considered statistically significant. IOP: Intraocular pressure, SD: Standard deviation

**Table 2:** Variation of IOP with SBP

| SBP (mmHg) | Number of subjects | IOP (mmHg) | | *P* |
|---|---|---|---|---|
| | | Mean | SD | |
| <120 | 50 | 15.38 | 2.33 | 0.0001 |
| 120-139 | 70 | 16.06* | 2.07* | |
| 140-150 | 60 | 17.15*** | 2.09*** | |

Statistical analysis of data was done using one-way ANOVA. *Comparison with subjects having BP <120 mmHg, **P*>0.05, ****P*>0.001. IOP: Intraocular pressure, SBP: Systolic blood pressure, BP: Blood pressure, SD: Standard deviation

**Table 3:** Variation of IOP with DBP

| DBP (mmHg) | Number of subjects | IOP (mmHg) | | *P* |
|---|---|---|---|---|
| | | Mean | SD | |
| <80 | 44 | 15.51 | 2.42 | 0.004 |
| 80-90 | 89 | 16.17 | 2.12 | |
| 91-100 | 47 | 17.04** | 2.11** | |

Statistical analysis of data was done using one-way ANOVA. *Comparison with subjects having BP <80 mmHg, ***P*>0.01. IOP: Intraocular pressure, DBP: Diastolic blood pressure, SD: Standard deviation, BP: Blood pressure

**Table 4:** Correlation of IOP with SBP and DBP

| Relation of IOP with | Correlation coefficient | | | Regression coefficient | IOP estimation (mmHg) |
|---|---|---|---|---|---|
| | *r* | *t* | *P* | | |
| SBP | +0.317 | 3.20 | 0.006 | 0.100 | IOP=9.88+0.049 (SBP) |
| DBP | +0.265 | 2.63 | 0.015 | 0.07 | IOP=10.90+0.063 (DBP) |

Statistical analysis of data was done using Pearson's correlation co-efficient and *P*>0.05 was considered statistically significant. IOP: Intraocular pressure, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

## DISCUSSION

In the present study, we have studied the relationship between IOP and BP and the gender difference in IOP. On analyzing the gender difference, it was found that IOP was more in females compared to males, but the increase in IOP in females was not statistically significant. Previous studies have also reported that women have higher IOP, and they were more susceptible to ocular hypertension or glaucoma compared to men.[7-9]

Studies have also reported that subjects on antihypertensive medications are 2–3 fold increased risk of glaucoma.[10-12] Previous studies have been conducted either on normotensives or on hypertensives on antihypertensive therapy. Therefore, to the best of our knowledge, this is the first study conducted on newly diagnosed adult Indian hypertensives not under medication.

Most studies have reported positive correlation between systemic hypertension, especially SBP[13-15] and DBP with raised IOP.[16-18] Moreover, Baltimore Eye Survey has reported high IOP and systemic hypertension as potential risk factors for glaucoma.[5] However, studies have also documented conflicting reports of increased risk of glaucoma with lower SBP and DBP.[17,19] In our study, IOP was found to be increasing with increase in BP [Tables 2 and 3] and both SBP and DBP were positively and significantly correlated with IOP [Table 4]. Therefore, both prehypertensives and hypertensive were at increased risk for the developing glaucoma compared to normotensives.

Increased filtration of aqueous fluid in the ciliary body due to the increased perfusion pressure in the ciliary arteries may be the most likely explanation for the direct relationship between intraocular and systemic pressure.[20] High BP increases the ocular pressure by enhancing the ultrafiltration of aqueous by increasing the ciliary artery pressure.[16] The other possible mechanisms for increase in IOP with systemic pressure may be increased retinal blood volume after a rise in central retinal vein pressure because of increased pressure in the adjacent central retinal artery, increased blood volume in the ciliary body. As age advances, there may be some structural changes in the trabecular meshwork and this, in turn, may decrease the facility of aqueous outflow owing to an increase in resistance in the episcleral and anterior ciliary veins, thereby elevating the IOP.[21]

### Limitations of the study

We could not follow-up these hypertensive patients for the development and progression of glaucoma. Therefore, future longitudinal studies should be conducted on a larger population of hypertensives to assess the independent contribution of BP for the development of glaucoma, even in the presence of other potential risk factors.

## CONCLUSION

The findings of the present study suggest that there was no gender difference in IOP in the studied population, and IOP increases with rise in BP. Screening of IOP is of utmost importance in patients with hypertension as it helps to prevent glaucoma, which is the second most common cause of blindness and visual impairment worldwide.

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**Conflicts of interest**

There are no conflicts of interest.

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