



# Correlation between Intraocular Pressure and Blood Pressure at Primasatya Husada Citra Hospital Surabaya

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

## Article Information

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## ABSTRACT

**Background and Objective:** Intraocular pressure (IOP) depends on a variety of local and systemic factors, including systemic blood pressure. This study conducted to analyze the correlation between IOP and blood pressure (BP).

**Methods:** This was a cross-sectional study conducted in Ophthalmology Clinic Primasatya Husada Citra Hospital Surabaya from September 2021 until October 2021 with consecutive sampling. The statistic analyzed using Kruskal-Wallis test and Pearson correlation test in SPSS program version 24.0.

**Results:** A total 115 patients were included, 69 (60%) females and 46 (40.0%) males. Mean age was  $35.78 \pm 11.64$  years old. This study revealed a significant difference in intraocular pressure in both eyes between subjects in four categories of BP ( $p=0.000$ ). Positive correlation was found between IOP and BP of the right eyes ( $R = 0.393$ ,  $P = 0.000$ ) and left eyes ( $R = 0.363$ ,  $P = 0.000$ ).

**Conclusion:** There was a statistically significant correlation between IOP and BP ( $p=0.000$ ), which the higher BP, the higher IOP in both eyes.

*Keywords:* Intraocular pressure; blood pressure.

## 1. INTRODUCTION

Intraocular pressure (IOP) depends on a variety of local and systemic factors. Elevation of IOP is hypothesized to proportionally increase in systemic blood pressure. The physiologic basis for the correlation of IOP and systemic blood pressure may be the increased production of aqueous humor by ultrafiltration due to increased ciliary arterial pressure or increased in episcleral venous pressure [1].

Glaucoma is a group of progressive optic neuropathy caused by damage to the lamina cribrosa, which the main site of structural injury that can cause optic disc excavation or "cupping", and loss of ganglion cells and retinal axons. Elevated intraocular pressure (IOP) is a major risk factor for optic nerve damage in glaucoma, but that is the only modifiable risk factor [2-5].

An estimated 60 million people worldwide suffer from optic neuropathy due to glaucoma and it is estimated that by 2040 will increase to 111.8 million [6]. As the leading cause of irreversible blindness in the world, glaucoma poses a significant public health problem [3].

Ocular hypertension and glaucoma can be prevented from blindness if detected early and treated appropriately. Detailed literature on changes in IOP due to systemic parameters such as BP is not yet available, especially in Indonesian population. Knowing that high blood pressure can elevate the IOP highlight the importance to maintain blood pressure within normal limit. Thus, the purpose of this study is to find the correlation between IOP and BP.

## 2. METHODS

This study was cross-sectional study conducted in Ophthalmology Clinic Primasatya Husada Citra Hospital Surabaya from September 2021 until October 2021. Based on Lemeshow formula, we included 115 subjects with consecutive sampling. The inclusion criteria were patients visiting ophthalmology clinic on period of study, aged 20-60 year old. The exclusion criteria were patients who has (1) history of glaucoma or under medication of glaucoma, (2) history of hypertension and under medication of hypertension, (3) body mass index (BMI) above 30 kg/m<sup>2</sup>, (4) under steroid treatment (topical, systemic, periocular, inhalation), (5) undergone eye surgery, (6) smoker (>100 cigarettes in

his/her life and is still smoking) (7) Alcoholic (> 1 time/month), (8) history of chronic kidney disease (CKD), (9) severe myopia (>6 diopters).

### 2.1 Materials

Systemic blood pressure (BP) was measured using GEA mercurial sphygmomanometer in right arm in sitting position. On the basis of BP, subjects were divided into 3 groups: normal, high-normal, and hypertensive. According to *American Heart Association* (AHA) 2020, systolic (SBP) and diastolic blood pressure (DBP) categorize as follows: (1) normal: SBP <130 and DBP <85 mmHg, (2) high-normal: SBP 130-139 and/or DBP 85-89 mmHg, (3) hypertensive grade 1: SBP 140-159 and/or DBP 90-99 mmHg, (4) hypertensive grade 2: SBP ≥ 160 and/or ≥100 mmHg.

Intraocular pressure (IOP) was measured using *non-Contact Tonometers* Canon TX – 20P. To avoid the effect of diurnal variation, the readings were taken during 9-11 am.

Primary data included patient's age, sex, BP and IOP were taken. Normal distribution of variables was examined using Shapiro-Wilk test. Since the data was not distributed normally, we used the Kruskal-Wallis test to determine the differences between two groups. The correlation analyzed using Pearson correlation. The statistical analyses were done using SPSS program version 24.0 with p value of 0.05 or less was regarded statistically significant.

## 3. RESULTS

A total 115 patients were included, consisting 69 (60%) females and 46 (40.0%) males. Mean age 35.78 ± 11.64 years old. Mean SBP was 126.96 ± 18.073 mmHg and mean DBP was 80.96 ± 11.315 mmHg. A total 58 subjects (50.4%) in normal tension, 26 (22.6%) in high-normal group, 18 (15.7%) in hypertension grade 1, and 13 (11.3%) in hypertension grade 2 (Table 1).

The intraocular pressure of this study showed a significant difference in both eyes between four groups of blood pressure (Kruskal-Wallis, P = 0.000). The mean intra-ocular pressure in the right and left eyes in each group and the statistical analysis are shown in Table 2.

We found a positive correlation between intra-ocular pressure and blood pressure of the right eyes (Pearson Correlation Coefficient, R = 0.393,

P = 0.000) and left eyes (Pearson Correlation Coefficient, R = 0.363, P = 0.000) (Table 3). It suggests that a higher BP is correlated with a higher IOP.

**Table 1. Characteristic of subjects**

|                       | N  | Percentage (%) |
|-----------------------|----|----------------|
| <b>Sex</b>            |    |                |
| Female                | 69 | 60.0           |
| Male                  | 46 | 40.0           |
| <b>Blood pressure</b> |    |                |
| Normal                | 58 | 50.4           |
| High-normal           | 26 | 22.6           |
| Hypertension grade 1  | 18 | 15.7           |
| Hypertension grade 2  | 13 | 11.3           |

**4. DISCUSSION**

This study aimed to analyze the relationship between IOP and BP. We found that the mean IOP of the normal BP was lower than high-normal, hypertension grade 1 and 2 group, in both eyes (p=0.000, Table 2.). The analysis of the relationship between IOP and BP with Pearson's correlation coefficient showed a

positive and statistically significant relationship in both eyes (p=0.000, Table 3). It suggests that a higher BP is correlated with a higher IOP. Some studies also reported similar results to ours.

Baisakhiya et al reported that average IOP in non-hypertensive patients (<120/80 mmHg) 14.17 ± 2.14, in pre-hypertensive patients (systolic 120 – 139 mmHg, diastolic 80 – 89 mmHg) 15.45 ± 2.07, and hypertensive patients (systolic 140 mmHg, diastolic 90 mmHg) 17.93 ± 2.22 (Anova test, P < 0.001) [7].

Christopher J et al also reported that there were more patients with high IOP in the hypertension group (>140/90 mmHg) than in the non-hypertensive group (p= 0.044) [8].

Deb et al also reported that 108 of 208 patients with hypertension, the average value of intraocular pressure was 15.37 mmHg ± 2.01 mmHg, while other 100 patients in the control/non-hypertensive group showed an average result of 13.41 mmHg ± 2.82 mmHg [9].

**Table 2. Statistical comparison of IOP to BP using Kruskal-Wallis test**

|                      | Status BP      | IOP OD    | IOP OS    |
|----------------------|----------------|-----------|-----------|
| Normal               | N              | 58        | 58        |
|                      | Mean           | 15.8      | 15.6      |
|                      | 95% CI         | 14.9-16.6 | 14.8-16.4 |
|                      | Std. deviation | 3.26      | 3.05      |
| High normal          | N              | 26        | 26        |
|                      | Mean           | 17.1      | 16.7      |
|                      | 95% CI         | 15.8-18.3 | 15.4-18.0 |
|                      | Std. deviation | 3.1       | 3.1       |
| Hypertension grade 1 | N              | 18        | 18        |
|                      | Mean           | 18.7      | 20.5      |
|                      | 95% CI         | 17.3-20.2 | 16.2-24.8 |
|                      | Std. deviation | 3.0       | 8.5       |
| Hypertension grade 2 | N              | 13        | 13        |
|                      | Mean           | 19.3      | 19.4      |
|                      | 95% CI         | 17.6-20.9 | 17.9-20.8 |
|                      | Std. deviation | 2.8       | 2.4       |
| P value              |                | .000      | .000      |

\*BP: Blood Pressure, IOP: Intraocular Pressure

**Table 3. Correlation between IOP and BP using Pearson correlation coefficient**

| Ocular pressure | Blood pressure |         |
|-----------------|----------------|---------|
|                 | r-value        | P-value |
| Right IOP       | 0.393          | 0.000   |
| Left IOP        | 0.363          | 0.000   |

The mechanism for the increase in IOP at high blood pressure can be due to ultrafiltration of the ciliary epithelium caused by increased ciliary artery pressure and causes increased aqueous production.<sup>7</sup> Another mechanism may be due to antihypertensive drugs before bedtime, which can cause a decrease in blood pressure during sleep and decrease perfusion to the optic nerve head.<sup>9</sup> Langman et al and Topouzis et al reported hypotension, especially a decrease in blood pressure at night is an important risk factor for the development of open angle glaucoma [10,11].

Another possible association between the use of antihypertensives and the occurrence of open angle glaucoma is that patients tend to have more severe disease and in greater risk to have optic nerve head disorders. Chronically elevated blood pressure can lead to arteriosclerosis, changes in the size of the precapillary arterioles, and capillary ejection leading to increased resistance to blood flow and thus reduced perfusion [9].

This study has limitation that it was conducted with cross-sectional design with 1-month period. Longer period and larger sample size are recommended for further study. Besides, in this study, IOP was measured using *non-Contact Tonometers*. We highly recommend the use of Goldmann applanation as the gold standard for measuring IOP.

## 5. CONCLUSION

This study showed that there was correlation between blood pressure and IOP, which the higher BP, the higher IOP in both eyes. We found it statistically significant ( $r=0.393$  (RE),  $r=363$  (LE),  $p=0.000$ ).

## CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

## ETHICAL APPROVAL

This study was approved by the Health Research Ethics Commission of Medical Faculty Widya Mandala Catholic University based on WHO-CIOMS International Ethical Guidelines for Health-related Research Involving Humans.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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