



POSTMENOPAUSAL INTRAOCULAR PRESSURE CHANGES AND ITS CORRELATION WITH OCULAR PERFUSION PRESSURE, BLOOD PRESSURE AND BODY MASS INDEX

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ABSTRACT **AIM:** To compare the intraocular pressure in pre and post-menopausal women and correlate it with Blood Pressure, Body Mass Index Ocular Perfusion Pressure and Central Corneal Thickness **METHODS:** 202 women in the age group of 40-65 years were divided into premenopausal and postmenopausal groups based on their menstrual history. Assessment of height, weight, BMI and BP was done. All the subjects underwent a comprehensive ophthalmic evaluation. IOP was measured by Goldmann Applanation Tonometer, CCT by optical pachymetry and Ocular Perfusion Pressure was calculated. IOP was compared between the two groups. **RESULTS:** This study included 100 premenopausal (mean age of 47.12 + 3.15 years) and 102 postmenopausal women (mean age of 59.25 + 4.27 years). IOP and systolic BP values were significantly higher in the postmenopausal group ($P < 0.001$). A significant positive correlation was found between IOP and systolic BP and a negative correlation between IOP and OPP in the postmenopausal group. No correlation was found between IOP and BMI, CCT or duration of menopause. **CONCLUSION:** Our study found a significant increase in IOP, BMI and systolic BP among postmenopausal women, which may be attributed to female sex hormone level variations. **CLINICAL SIGNIFICANCE:** This knowledge could be extrapolated into use of BMI and BP values as tools among postmenopausal women for glaucoma screening. Postmenopausal women need periodic ophthalmological evaluation, so as to help in early detection of glaucoma and prevention of glaucoma blindness.

KEYWORDS : Intraocular pressure, menopause, case-control study, glaucoma screening, sex hormones

INTRODUCTION

Maintenance of normal intraocular pressure (IOP) important for normal ocular functioning. Longstanding IOP elevation can cause progressive glaucomatous optic nerve damage resulting in optic disc cupping and visual field defects.^[1,2]

IOP values can be influenced by many parameters such as age, gender, exercise, body position, diurnal variation, pregnancy and sex hormone levels. Multiple studies have reported a gender difference in the mean IOP levels since childhood with females recording higher IOP values than males. The variations in the levels of the sex hormones oestrogen and progesterone may influence IOP levels in females.

The WHO and the stages of reproductive aging workshop (STRAW) working group define menopause as the "permanent cessation of menses resulting from reduced ovarian hormone secretion that occurs naturally or is induced by surgery, chemotherapy or radiation". 12 consecutive months of amenorrhoea is considered as menopause. It is a period characterized by a changing hormone profile in the body, causing important shifts in the levels of sex hormones, like oestrogen and progesterone. There is an oestrogen deficient state resulting from the loss of ovarian activity. The loss of oestrogen often causes marked physiologic changes in the function of the body and the eye is no exception. These variations in the sex hormone levels have been shown to be the predominant causes for variations in IOP.^[3]

Oestrogen brings about a decrease in IOP by increasing the nitric oxide levels causing relaxation of the trabecular meshwork. Additionally, its effect on regulating the vascular resistance due to its vasodilative action supports the vascular theory of glaucoma.^[1,4] Progesterone, by competing with the endogenous glucocorticoid receptor binding sites, reduces the ocular hypertensive effects of glucocorticoids.^[1,5] The variations in the levels of these hormones following menopause have been shown to cause IOP variations.

This study was undertaken to compare the IOP levels between pre and postmenopausal women and correlate it with various parameters like ocular perfusion pressure (OPP), central corneal thickness (CCT), blood pressure (BP) and body mass index (BMI).

MATERIALS AND METHODS

This observational, case control study was performed with the approval of the Institutional Ethical Committee. All females between

40-65 years of age attending the Ophthalmology OPD during the study period between March 2020 and August 2020 were invited to participate in the study. Written informed consent was taken from all the participants.

The study participants were divided into two groups – the Pre-menopausal group included healthy females aged between 40-55 years, who were still menstruating and the post-menopausal group included healthy females aged between 50-65 years, with amenorrhoea for more than one year.

The exclusion criteria were as follows: Women aged < 40 years or > 65 years, history diabetes mellitus, hypertension, history of premature menopause/surgical menopause, history of hypothyroidism, liver damage; use of steroids or hormone replacement therapy; history of ocular diseases (glaucoma, high degrees of refractive errors, uveitis etc.) and women who have undergone any intraocular surgeries within the past 3 months.

Relevant demographic data and a detailed history was obtained from all the enrolled subjects. Height was measured without footwear (to the nearest of 0.1 centimetre) using a vertically movable scale. Weight was measured using a digital scale (to the nearest 100 grams). Body Mass Index (BMI) was calculated using the formula of Weight (in kgs) / (Height in meters)².

Resting Systolic blood pressure (SBP) and Diastolic blood pressure (DBP) was measured, with the subject in a supine posture and after a rest of 15 minutes in this posture, using a mercury Sphygmomanometer.

Comprehensive ophthalmological examination was done by a glaucoma specialist which included visual acuity assessment and refractive error testing, slit lamp examination, IOP measurement using Goldman Applanation tonometer, Optic nerve head examination by slit lamp fundus biomicroscopy using +90D lens and Central Corneal Thickness measurement by Ultrasound Pachymetry.

Ocular Perfusion Pressure (OPP) was calculated using the following formula: $OPP = \frac{2}{3} (\text{Mean Arterial Pressure} - \text{IOP})$ where Mean Arterial Pressure (MAP) = $DBP + \frac{1}{3} (SBP - DBP)$

The IOP values were compared between the two groups. IOP values

were also analyzed in order to establish correlation with parameters such as BMI, BP, CCT, OPP and duration of menopause.

Statistical Analysis:-

All the quantitative variables like age, intraocular pressure, etc. are presented in terms of descriptive statistics such as Mean and Standard Deviation.

Analysis was done using SPSS version 23.0. Significance of study parameters between the groups was assessed using Unpaired students' 't' test. The correlation between different variables was analyzed using Pearson's correlation analysis. P value of 0.05 or less was considered statistically significant.

RESULTS:-

A total of 202 eligible participants were included in this study consisting of 100 pre-menopausal women and 102 post-menopausal women. The mean age of the postmenopausal group was 59.25 ± 4.27 years, and that of the premenopausal group was 47.12 ± 3.15 years. [Table 1]

Table 1: Mean Baseline Parameters of Pre-menopausal and Post-menopausal women

Parameters	Premenopausal		Menopausal		Unpaired t test	
	Mean	Std. Deviation	Mean	Std. Deviation	P value	Significance
Age	47.18	1.96	59.45	4.03	<0.001	Sig
BMI	24.26	3.07	26.06	2.59	<0.001	Sig
CCT (RE)	523.21	27.23	520.35	27.12	0.228	NS
CCT (LE)	523.21	25.91	517.68	23.46	0.057	NS
SBP	124.58	7.83	131.39	8.14	<0.001	Sig
DBP	79.38	7.17	79.67	6.99	0.387	NS
OPP(RE)	80.93	6.58	80.68	6.60	0.397	NS
OPP(LE)	80.99	6.54	80.74	6.12	0.392	NS
Duration of Menopause	-	-	8.81	4.16	-	-

* Sig= Significant; NS= Not Significant

The mean IOP was 13.52 mm Hg (Right eye) and 13.46 mm Hg (Left eye) in pre-menopausal women and 16.46 mm Hg (Right eye) and 16.42 mm Hg (Left eye) in post-menopausal women. Intra-ocular pressure was found to be significantly higher in post-menopausal women than in pre-menopausal women (P<0.05). [Table 2]. Central corneal Thickness was found to be comparable between the two groups.

Table 2: Intra-ocular Pressures In Pre And Post-menopausal Women

Intra-ocular Pressure	Premenopausal		Menopausal		Unpaired t test	
	Mean	Std. Deviation	Mean	Std. Deviation	P value	Significance
Right eye	13.52	2.35	16.46	2.21	<0.001	Sig
Left eye	13.46	2.08	16.42	2.14	<0.001	Sig

* Sig= Significant

BMI was found to be higher in postmenopausal women (24.26 + 3.07 in premenopausal group vs 26.06+2.59 in postmenopausal group; p < 0.001).

Systolic BP was significantly higher in the postmenopausal group (131.39+ 8.14 mm Hg vs 124.58+ 7.83 mm Hg p<0.05). There was no statistically significant difference in diastolic BP and ocular perfusion pressure between both the groups. The mean duration of menopause was found to be 8.81 (+ 4.16) years in post-menopausal women. [Table 1] There was found to be a significant positive correlation between IOP and Systolic Blood Pressure (SBP) and a significant negative correlation between IOP and OPP. However, no significant correlation was found between intra-ocular pressure in the postmenopausal women and other parameters such as BMI, Diastolic Blood Pressure (DBP), Central Corneal Thickness (CCT) and Duration of menopause. [Table 3]

Table 3: Pearson Correlation of Intra-Ocular pressure with

various parameters

Parameters		IOP (RE)	IOP (LE)
BMI	r Value	0.070	0.125
	P Value	0.319	0.076
	Significance	NS	NS
SBP	r Value	0.224	0.288
	P Value	0.001	<0.001
	Significance	Sig	Sig
DBP	r Value	-0.066	-0.052
	P Value	0.351	0.462
	Significance	NS	NS
Duration of Menopause	r Value	0.082	0.113
	P Value	0.414	0.259
	Significance	NS	NS
OPP	r Value	-0.332	-0.238
	P Value	<0.001	0.001
	Significance	Sig	Sig
CCT	r Value	-0.0013	-0.057
	P Value	0.989	0.42
	Significance	NS	NS

* Sig= Significant; NS= Not Significant

DISCUSSION:

Glaucoma is one of the leading causes of irreversible blindness. High IOP is one of the important factors that can cause glaucoma. It has been found that IOP significantly increases in women after menopause.

Although raised IOP is not the only risk factor for optic nerve injury, the development of a glaucomatous optic nerve damage, which can be observed by visual field loss and/or optic disc cupping, is more likely to be associated with an abnormally high intraocular pressure [1,2]. Many physiological factors may affect IOP in normal subjects and this may sometimes be marked and relatively sustained [1,3]

Hulsman et al. found an association between early menopause and open-angle glaucoma. [6] There was a higher risk of open-angle glaucoma in women who went through natural menopause before the age of 45 years. A study taken up by I. A. Qureshi in Pakistan also showed that menopause significantly increased intraocular pressure. [7] Ebeigbe et al. also found, in their study, that IOP in the postmenopausal group was significantly higher than that in their premenopausal group. [3] In our study too, similar results were obtained.

A study conducted by Nirmala N. et al. showed positive association between systolic BP and raised IOP. [8] Wong et al. also showed that an increase in systolic BP was associated with an increase in IOP. [9] Similarly, we found a significant positive correlation between intra-ocular pressure and systolic blood pressure.

Mori et al., in their study, showed that increased BMI was strongly associated with risk of increased IOP. [2] A study carried out in a Korean population found that the mean IOP increased proportionally with degree of obesity in both males and females [10]. Similar findings were also reported in Barbados and the Beaver Dam Eye studies [11,12], where a large body size, measured by BMI, was associated with an increasing IOP. However, our study does not show any correlation between BMI and IOP.

A negative correlation was found between IOP and Ocular Perfusion Pressure in our study. Hence, as IOP increases, OPP reduces, more so in post-menopausal women. Recent epidemiologic studies and clinical trials have found that a low ocular perfusion pressure is significantly related to Open Angle Glaucoma. [13] Hence, this can lead to increased risk of glaucoma in post-menopausal women.

Studies have also documented a reduction in IOP with hormone replacement therapy (HRT) in post-menopausal women [14,15]. Hence, it is postulated that hormonal changes in menopausal women might have an influence on IOP, lower hormonal levels leading to higher IOP in postmenopausal women.

Although earlier studies have not shown a direct effect about number of years after attaining menopause, as also in our study, an increased risk of open angle glaucoma in women who experience an early natural menopause has been demonstrated. [16] However, since this study is

cross-sectional, longitudinal changes in terms of IOP with the other parameters cannot be assumed.

CONCLUSION:

In this study, we made an attempt to find the effect of menopause on IOP. We found a significant increase in IOP, BMI and SBP among postmenopausal women which may be attributable to female sex hormone level variations.

Further studies can be carried out to establish the relationship between IOP and sex hormones, like Oestrogen and Progesterone, in order to determine if hormone replacement therapy can be used for protection against raised IOP.

Clinical Significance:

This knowledge could be extrapolated into the use of BMI and BP values as glaucoma screening tools among postmenopausal women. Additionally, these women need periodic ophthalmological evaluation, so as to help in early detection of glaucoma and prevention of glaucoma blindness. Oestrogen replacement and regulation of BP and BMI in the postmenopausal period may offer protection against raised IOP.

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