ORIGINAL ARTICLE

INTRAOCULAR PRESSURE AND CENTRAL CORNEAL THICKNESS IN HYPERTENSIVE AND NON-HYPERTENSIVE PATIENTS

Rehab Habib, Rana Mohammad Mohsin Javed*, Farhat Ijaz, Rana Khurram Aftab***, Hira Sohail†, Rana Rakhshan Aftab††**

Department of Physiology, King Edward Medical University, *Department of Ophthalmology, Mayo Hospital, **Department of Physiology, CMH Lahore Medical College and Institute of Dentistry, ***Punjab Institute of Cardiology, Lahore, †Department of Biochemistry, CMH Lahore Medical College and Institute of Dentistry, ††Rashid Latif Medical College, Lahore, Pakistan

Background: Intraocular pressure (IOP), the pressure inside the eyeball, is retained by balance between production and drainage of aqueous humour. It fluctuates with age, central corneal thickness (CCT), blood pressure, vascular disease, diabetes and myopic refractive error. This study was done to compare IOP and CCT and to correlate these parameters with age in hypertensive and non-hypertensive patients. **Methodology:** This study was conducted at Ophthalmology Department, Mayo Hospital, Lahore. A total of 108 subjects were included in the study and divided into two groups of 54 each. Blood pressure was checked using mercury sphygmomanometer. IOP was assessed with Goldman aplannation tonometer and CCT was measured with ultrasound pachymeter. **Results:** Mean age of patients with hypertension was 56.37±6.7 and non-hypertensive patients were 52.35±5.92 years. IOP was significantly higher in hypertensive patients as compared to non-hypertensive patients (p<0.001). CCT was not statistically significant in hypertensive and non-hypertensive people in both right and left eyes. **Conclusion:** Mean IOP and CCT were significantly higher in hypertensive subjects. IOP showed weak negative and CCT showed weak positive correlation with age in hypertensive patients.

Keywords: IOP, CCT, hypertension

Pak J Physiol 2020;16(1):3–5

INTRODUCTION

The pressure inside the eye ball, intraocular pressure (IOP) is retained by balance between production and drainage of aqueous humour. Its value ranges from 11–21 mmHg. It fluctuates with age, central corneal thickness, blood pressure, vascular disease, diabetes and myopic refractive error.[1] Routinely, IOP shows 24-hourly variation favouring to be higher in morning and lower in evening. It shows diurnal variation of 5 mmHg. Far sighted eyes show greater diurnal variation than near sighted eyes.[2] It can be assessed with applanation, indentation and pneumatic methods. But gold standard measurement is based on Imbert-Fick principle. It can be documented with Goldmann applanation tonometer. IOP measurement is directly connected with flattening of cornea so central corneal thickness (CCT) is the key determinant of IOP. It is normally 490–560 μm thick centrally.[3] It can be assessed with ultrasound or optical pachymeter. Clinically CCT measurement plays a direct role in management of 15% of patients of glaucoma.[4] Main independent determinant of higher IOP is the high blood pressure.[5]

Hypertension risk increases with low physical activity, use of tobacco, high salt intake, and unhealthy diet. Another important risk factor for hypertension is aging.[6] There exists a strong correlation between IOP, age, blood pressure and CCT.[7] IOP increases with increased systolic blood pressure and with younger age.[8] According to another study, IOP decreases with age.[9] It was also reported in a study that there is no significant correlation of CCT with IOP, age, gender and hypertension.[10] Another study observed that there is no significant association of IOP with age and body mass index.[11]

IOP is the only genuine risk factor in Glaucoma which can be modified. Therefore, it is significant to evaluate the characteristics that are associated with raised IOP. Several factors are associated with raised IOP, i.e., age, gender, central corneal thickness, race, blood pressure, body mass index, lens status, etc. Literature review showed that systemic blood pressure (BP) is related with IOP, however results obtained from various studies reporting associations of BP with IOP and CCT are controversial. We aimed to compare and correlate all these factors in both hypertensive and non-hypertensive population to generate new data for our population directly affecting the diagnosis and management of patients with glaucoma.

MATERIAL AND METHODS

This case control study was conducted in the Department of Ophthalmology, Mayo Hospital, Lahore, in 2017 after approval from Advance Studies and Research Board, KEMU, Lahore. Non-probability convenient sampling was done.

One hundred and eight (108) subjects were included in the study (54 in each group). Written

informed consent was taken and complete ophthalmic examination was done. Visual acuity and slit lamp examination was done to rule out anterior segment pathologies. Blood pressure was measured in sitting position with mercury sphygmomanometer and average of three readings was recorded. IOP was measured in both eyes with Goldmann aplannation tonometer after applying topical proparacaine 0.5% and 2% fluorescein strips. The CCT was measured with ultrasound pachymeter.

Data was analysed using SPSS-17. Mean±SD was calculated for normally distributed quantitative variables. Pearson's Correlation coefficient was used to observe the correlation between IOP, CCT, and age, and $p<0.05$ was considered as statistically significant.

RESULTS

Mean age of hypertensive patients was 56.37±6.71 years and non-hypertensive patients were aged 52.35±5.92 years. Mean IOP in right and left eye was significantly higher in hypertensive patients than non-hypertensive patients (p= 0.000). The CCT in right and left eye was higher in non-hypertensive subjects but not statistically significant. (Table-1).

For right eye negative weak correlation was seen between IOP and age of patients in hypertensive patients while in non-hypertensive patients positive week correlation was seen between IOP and age, i.e., (R): r (HTN)= -0.204, p= 0.140, r (N-HTN)= 0.271, p= 0.048.

For left eye negative weak correlation was seen in hypertensive and in non-hypertensive patients no significant correlation was seen between IOP and age, i.e., (L): r (HTN)= -0.291, p= 0.033, r (N-HTN)= 0.001, p= 0.992.

Among hypertensive patients no statistically significant correlation was seen between CCT and age in right and left eye. Among non-hypertensive individuals weak negative correlation was seen between CCT and age in right and left eye, i.e., (R): r (HTN)= 0.025, p= 0.857, and (L): r (HTN)= 0.087, p=0.533. (R): r (N-HTN)= -0.303, p= 0.026 and (L): r (N-HTN)= -0.267, p= 0.051.

In right eye correlation between CCT and IOP in hypertensive and non-hypertensive individuals was statistically not significant. (R): r (HTN)= -0.064, p= 0.648, r (N-HTN)= 0.006, p= 0.965.

Similarly in left eye a linear weak negative and significant correlation was seen between CCT and IOP in hypertensive patients while in non-hypertensive patients' correlation between CCT and IOP was very weak and statistically not significant. (L): r (HTN)= -0.286, p= 0.036, r (N-HTN)= 0.010, p= 0.943.

Table-1: Age, IOP and CCT in hypertensive and non-hypertensive patients

Parameters	Hypertensives	Non-hypertensives	*p*
Age (Years)	56.37±6.71	52.35±5.92	
IOP (Right eye)	17.38±3.99	14.05±3.98	0.000
IOP (Left eye)	18.77±6.86	15.09±2.84	0.000
CCT (Right eye)	525.90±30.16	529.57±42.51	0.606
CCT (Left eye)	526.42±28.84	533.38±37.93	0.285

DISCUSSION

Intraocular pressure is linked with glaucoma, and in a number of studies it has been found that corneal thickness is significantly associated with IOP. Yet, a number of authors have claimed that a linear correlation does not exist between IOP and CCT. Studies have also reported altering values of CCT in different racial groups.[12–15]

Gelaw *et al*[15] and Iyamu *et al*[16] found no significant association between these two parameters. Several factors including age, gender, refractive error, diurnal variations, genetic influence, and diseases like diabetes mellitus have been shown to affect CCT. Some studies reported positive correlation among blood pressure and IOP.[17–18] Klein *et al* in their study showed that there was a significant correlation between IOP and both systolic and diastolic BP.[19] Among both hypertensives and normotensives the correlation was not statistically significant; CCT was also vey weakly correlated with age of hypertensive patients. Though, controversial results have also been reported for CCT and IOP in association with age of patients.

A study from Karachi found very weak correlation between CCT and IOP in healthy adults.[13] An Indian study compared IOP differences in postmenopausal hypertensive and normotensive women. They observed statistically significant correlation between IOP and BP in hypertensive postmenopausal women.[18]

Ebeigbe *et al*, in their study reported that mean IOP of women who were postmenopausal and hypertensive was significantly higher when compared with normotensive postmenopausal women.[17] A study from Pakistan concluded that CCT is an important predictor of IOP and there was a statistically significant link/association between CCT and IOP when measured in normal healthy subjects. On the other hand a very weak but significant correlation was seen among IOP and CCT.[20]

Wong *et al*[7] reported that characteristics of study population such as age, central corneal thickness and SBP are important determinants of IOP in persons aged 40 to 80 years with central corneal thickness being more important determinant in younger persons. The divergent effects of age-related changes in systolic BP and CCT work together to lead to a moderately flat profile of intraocular pressure with age, probably through a slight reversed U-shaped association.[7]

A longitudinal study by Fukuoka *et al* analysed the intraocular pressure changes in young and middle-aged, healthy subjects. In middle-aged subjects a reduction in IOP over a 10 year period was observed.[21]

Nomura *et al*[9], and Shiose *et al*[22] reported a descending tendency of IOP with increasing age. A decrease of 1 mm Hg in men and 0.5 mm Hg in women between the third and eighth decade was reported and a decrease of 1 mm Hg in all subjects between the same two decades was seen. In contrast, the Egna-Neumarkt and Barbados Eye studies found that as age increases IOP also increase, showing that the effect of age on IOP is strong and persistent.[23–24]

CONCLUSION

Mean IOP and CCT were significantly higher in hypertensive subjects. Measurement of central corneal thickness is advisable when the clinical findings do not correlate with IOP. Hypertensives need to be monitored over time for their progression to Open Angle Glaucoma.

REFERENCES

1. Kanski JJ and Bowling B, Nischal KK, Pearson A. Clinical ophthalmology: a systematic approach, 7th ed. New York: Elsevier; 2011.
2. Feltgen N, Leifert D, Funk J. Correlation between central corneal thickness, applanation tonometry, and direct intracameral IOP readings. Br J Ophthalmol 2001;85(1):85–7.
3. Loewen NA, Liu JH, Weinreb RN. Increased 24-hour variation of human intraocular pressure with short axial length. Invest Ophthalmol Vis Sci 2010;51:933–7.
4. Weizer JS, Stinnett SS, Herndon LW. Longitudinal changes in central corneal thickness and their relation to glaucoma status: An 8 year follow up study. Br J Ophthalmol 2006;90:732–6.
5. Foster PJ, Machin D, Wong TY, Ng TP, Kirwan JF, Johnson GJ, *et al*. Determinants of intraocular pressure and its association with glaucomatous optic neuropathy in Chinese Singaporeans: the Tanjong Pagar Study. Invest Ophthalmol Vis Sci 2003;44:3885–91.
6. Krishnan A, Garg R, Kahandaliyanage A. Hypertension in south-asia region: An overview. REGIONAL HEALTH FORUM WHO South-East Asia-region. World Health Organization 2013;17(1):7–14.
7. Wong TT, Wong TY, Foster PJ, Crowston JG, Fong CW, Aung T, *et al*. The relationship of intraocular pressure with age, systolic blood pressure, and central corneal thickness in an Asian population. Invest Ophthalmol Vis Sci 2009;50:4097–102.
8. Tomoyose E, Higa A, Sakai H, Sawaguchi S, Iwase A, Tomidokoro A, *et al*. Intraocular pressure and related systemic and ocular biometric factors in a population-based study in Japan: the Kumejima study. Am J Ophthalmol 2010;150:279–86.
9. Nomura H, Ando F, Niino N, Shimokata H, Miyake Y. The relationship between age and intraocular pressure in a Japanese population: the influence of central corneal thickness. Curr Eye Res 2002;24(2):81–5.
10. Channa R, Mir F, Shah MN, Ali A, Ahmad K. Central corneal thickness of Pakistani adults. J Pak Med Assoc 2009;59:225–8.
11. Xu L, Wang H, Wang Y, Jonas JB. Intraocular pressure correlated with arterial blood pressure: the Beijing Eye Study. Am J Ophthalmol 2007;144:461–2.
12. Godar S, Kaini K, Khattri J. Factors affecting the central corneal thickness in Nepalese population. Nepal J Med Sci 2012;1(1):7–10.
13. Mohamed NY, Hassan MN, Ali NAM, Binnawi KH. Central corneal thickness in Sudanese population. Sud J Ophthalmol 2009;1(1):29–32.
14. Eballe AO, Koki G, Ellong A, Owono D, Epee E, Bella LA, *et al*. Central corneal thickness and intraocular pressure in the Cameroonian nonglaucomatous population. Clin Ophthalmol 2010;4:717–24.
15. Gelaw Y, Kollmann M, Irungu NM, Ilako DR. The influence of central corneal thickness on intraocular pressure measured by Goldmann applanation tonometry among selected Ethiopian communities. J Glaucoma 2010;19:514–8.
16. Iyamu E, Ituah I. The relationship between central corneal thickness and intraocular pressure: a comparative study of normals and glaucoma subjects. Afr J Med Med Sci 2008;37:345–53.
17. Ebeigbe JA, Ebeigbe PN, Ighoroje ADA. Intraocular pressure in postmenopausal Nigerian women with and without systemic hypertension. Afr Vis Eye Health 2011;70:117–22.
18. Nirmala N, Adhilakshmi A, Jain H, Karthika Priyadarshini U. A comparative study of intraocular pressure changes in postmenopausal normotensive and hypertensive women. Int J Res Med Sci 2014;2:876–80.
19. Klein B, Klein R, Knudtson MD. Intraocular pressure and systemic blood pressure: longitudinal perspective: the Beaver Dam Eye Study. Br J Ophthalmol 2005;89(3):284–7.
20. Shah MA, Saleem KB, Mehmood T. Intraocular pressure measurement: Goldmann applanation tonometer *vs* non contact airpuff tonometer. J Ayub Med Coll Abbottabad 2012;24(3–4):21–4.
21. Fukuoka S, Aihara M, Iwase A, Araie M. Intraocular pressure in an ophthalmologically normal Japanese population. Acta Ophthalmol 2008;86:434–9.
22. Shiose Y. The aging effect on intraocular pressure in an apparently normal population. Arch Ophthalmol 1984;102:883–7.
23. Bonomi L, Marchini G, Marraffa M, Bernardi P, Franco D, Perfetti S, *et al*. Prevalence of glaucoma and intraocular pressure distribution in a defined population: the Egna-Neumarkt Study. Ophthalmology 1998;105:209–15.
24. Leske MC, Connell AM, Wu SY, Hyman L, Schachat AP. Distribution of intraocular pressure: the Barbados Eye Study. Arch Ophthalmology 1997;115:1051–7.

Address for Correspondence:

Dr Farhat Ijaz, Assistant Professor Physiology, CMH Lahore Medical College and Institute of Dentistry, Natinal University of Medical Sciences, Lahore, Pakistan. **Cell:** +92-321-4932171

Email: farhat_khurram_rana@cmhlahore.edu.pk

Received: 2 Nov 2019 **Reviewed: 9 Feb 2020** **Accepted: 18 Feb 2020**

Authors' Contribution:

RH: Conceived, designed and Manuscript writing
RMMJ: Acquisition of data, analysis and interpretation
FI: Manuscript writing and Critical review
RKA: Literature review and Data Collection
HS: Revision and Final drafting
RRA: Data Collection and Proof reading

Conflict of interest: None
Financial support: None declared