International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 05, 2020
ISSN: 1475-7192

The Relationship between Refractive Errors and Intraocular Pressure After Adjusting with Central Corneal Thickness

*[1]Rabeea Mifath Mohammed Juwayli, [2]Adel Abdel Razik Farag, [3]Adel Abd El-Azim Shalaby, [4]Sherif Mohammed Sharf El Deen.

ABSTRACT

Background : *It is generally accepted that there is an increased prevalence of glaucoma among myopic eyes. One of the reasons as to whyglaucoma should be more frequent in myopic eyes seems to be higher intraocular pressure (IOP) in myopic eyes compared with non-myopic eyes.* ***Aim of the study:*** *This study was aimed to assess the correlation between refractive status and intraocular pressure after adjustment with Central corneal thickness.* ***Patients and Methods :*** *This Prospective cross-sectional study was conducted in Ophthalmology Department at Zagazig University Hospitals. 50 patients with refractive errors, divided in 2 groups 25 are myopic eyes and 25 are hypermetropic eyes. During the period from April to December 2019, Before the experiment, all patients underwent a complete ophthalmic examination, including visual acuity, manifest refraction, comprising refraction, slit lamp examinations and corneal topography.* ***Results:*** *There was a statistical significant negative correlation between spherical equivalent and IOP and AIOP (r=-0.728 and r=-0.499, P-value <0.05), regarding central corneal thickness, there was statistically significant negative correlation between AIOP and CCT(r=-0.419, p-value <0.05)but there was positive correlation between CCT and IOP(r=0.521, p-value<0.05). Conclusions: The myopic refractive error and the intra-ocular pressure seem to have a significant correlation as such that with the increase of myopic refractive error there was increase of the intra-ocular pressure. This findings support the hypothesis that the relationship between glaucoma and myopia might be pressure mediated.*

Keywords: *Central corneal thickness, Intraocular pressure, Sirius topography, Spherical equivalent refractive error*

I. INTRODUCTION

Accurate measurement of intraocular pressure is an important parameter in ophthalmic examinations, for the diagnosis and the follow-up of glaucoma. Goldmann applanation tonometer (GAT) is considered the standard for measurement of IOP. However, measurement with GAT depends on many factors, such as curvature

[1]*Department of Ophthalmology, Faculty of Medicine - Zagazig University*
[2]*Department of Ophthalmology, Faculty of Medicine - Zagazig University*
[3]*Department of Ophthalmology, Faculty of Medicine - Zagazig University*
[4]*Department of Ophthalmology, Faculty of Medicine - Zagazig University*

and central corneal thickness. Higher IOP values were detected by Rebound tonometry (RT). The IOP readings exceed the GAT values usually in a range of less than 1 mmHg generally in myopic eye. The (RT–GAT) discrepancy is related to the refractive error, but not to central corneal thickness (CCT**) [1]**.

IOP is positively correlated with the refractive errors. Myopes have higher IOP than the Emmetropes and the IOP of hyperopes is less compared to Emmetropes. Also raised IOP is the modifiable major risk factor for the development of glaucoma is influenced by other systemic parameters such as blood pressure and pulse pressure . Glaucoma is the second commonest cause of irreversible blindness and visual impairment **Han et al., [2]**.

The relationship between refractive error and IOP is an area of discrepancy. myopia may be associated with risk of primary open-angle glaucoma and hyperopia with possible risk of ocular hypertension. Considering this variability in IOP in different populations and the inconsistencies in relation to IOP with age, gender and refractive error [3].

The myopic refractive error and the intra-ocular pressure seem to have a significant correlation as such that with the increase of myopic refractive error there was increase of the IOP. The myopic refractive error and the CCT seem to have a significant correlation as such that with the increase of myopic refractive error there was decrease of the central corneal thickness[4].

Fern et al., [5], confirmed the relationship between central corneal thickness manifest refractive errors and intraocular pressure. The cornea of myopic eyes was significantly thinner than that of control and hyperopic eyes.

Central corneal thickness plays an important role in understanding the risk of glaucoma. Corneal thickness of less than 555µm provides false results of low intra ocular pressure, whereas, corneal thickness of more than 555µm provides a false result of raised intra ocular pressure when measured with GAT. IOP measurement is altered by corneal thickness [6]**.**

CCT and IOP have an independent effect on the risk of developing POAG. When GAT was introduced in the 1950s, the thickness of the cornea was recognized as a potential confounder to IOP measurement. A number of investigators have developed formulae to “adjust” IOP as measured by GAT for CCT. These formulae have been based on cannulation studies of eyes during cataract surgery **[7] .**

AIM OF THE WORK

The aim of the present work is to assess the correlation between refractive status and intraocular pressure after adjustment with Central corneal thickness .

II. PATIENTS & METHODS

This Prospective cross-sectional study was conducted in Ophthalmology Department at Zagazig University Hospitals. 50 patients with refractive errors, divided in 2 groups 25 are myopic eyes and 25 are hypermetropic eyes. During the period from May to December 2019.

Written informed consent was obtained from all children' parents, the study was approved by the research ethical committee of Faculty of Medicine, Zagazig University. The study was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Inclusion criteria: The patients are within 20-40 years old with no detectable systemic and ocular pathologies that could affect the outcome of the study. The spherical equivalent of refractive errors range in myopia from -1 to -6 and in hypermetropia from +1 to +6 .

Exclusion criteria: Patients with significant corneal pathology, such as scarring, edema, keratoconus or dystrophy, was excluded. Additionally, those with a history of recent contact lens wear, ocular surgery, ocular trauma or glaucoma or cataract were excluded. also, patients who will have evidence of systemic disease or pregnancy will be excluded. Lastly patients with astigmatism more than +3 or -3 are excluded too.

All patients were subjected to the following

Data collection: Data collected for all patients at time of hospital visit, The data-collection sheet

Full History taking from the patient including demographic characteristics, such as name ,age ,sex and gender

Ophthalmological examination including: External Examination. for eye brow and eye lids. Visual acuity by Snellen's Vision Box. Full Slit lamp examination to anterior and posterior segment of the eye. Tear brake up time and Ocular Surface Dye Staining with Fluorescein Green dye to assess the extent of ocular Surface damage.

Measurement of intraocular pressure : The IOP was assessed with the Slit-lamp mounted Goldmann applanation tonometer after sterilizing the tonometer probe with hydrogen peroxide and applying tetracaine Hcl 0.1% and staining the eye with wetted fluorescein strip. Three consecutive readings are taken and the average recorded as measured IOP (mIOP) in mmHg. Note that the IOP measurements were taken 10 minutes after pachymetry

Measurement of central corneal thickness by Sirius Topography with Scheimpflug Camera. Sirius (Costruzione Strumenti Oftalmici, Florence, Italy) topography consists of a combination of rotating Scheimpflug camera and placido disk, and allows full analysis of the topography and elevation of the anterior and posterior corneal surface and full corneal thickness [8].

All measurements of CCT and IOP were taken between 9am and 12 noon to avoid diurnal variation [9].

Regarding the adjusted IOP reading it was calculated following variable, GAT reading and CCT. The calculation by using a software of Sirius Topography with Ehllars Formula **.**

Assessment of the refractive error Objectively with Topcon KR.800 Computerised autorefractometer. Made in Japan, and Subjectively by Trial Box Containing Different Lenses and TrialFrame

Refractometry

The Refractometry (Optometry) is an objective method of finding out the error of refraction by use of an equipment called Refractometer. Refractometry utilizes the principles of indirect ophthalmoscopy. Presently, the computerised autorefractometers, both objective as well as subjective modern autorefractometers are

available commercially; which are being used increasingly. The computerised, autorefractometer quickly gives information about the refractive error of the patient in terms of sphere, cylinder with axis and interpupillary distance. This method is a good alternative to retinoscopy by busy practice. It is also advantageous for mass screening, research programmes and epidemiological studies. The subjective verification of refraction is a must even after autorefractometry[10].

Statistical Analysis: The collected data were analyzed by computer using Statistical Package of Social Services version 24 (SPSS), Continuous Quantitative variables were expressed as the mean ± SD & median (range), and categorical qualitative variables were expressed as absolute frequencies (number)& relative frequencies (percentage). The results were considered statistically significant when the significant probability was less than 0.05 (P <0.05).P-value < 0.001 was considered highly statistically significant (HS), and P-value ≥ 0.05 was considered statistically insignificant (NS).

III. Results

Table (1), showed that the mean age of the studied myopic group was32.3± 5.61years old, with a range from 23 to 40 years old. And 38.5% of them were males, while 61.5 % were females, while mean age of the studied hypermetropic group was 35± 6.59 years old, with a range from 20 to 40 years old. And 46.2 % of them were males, and 53.8 % were females, there was no statistically significant difference between both groups regarding sex and age. Table (2), showed that among the studied myopic group BCVA was 1.0 in 88 % of the studied eyes also among the studied hypermetropic group BCVA was 1.0 in 88% of the studied eyes, with no statistically significant difference between both groups. Table (3), showed that the mean IOP of the studied myopic group was 17.44± 2.41 mmhg, while among the studied hypermetropic group it was 13.92± 1.8 mmhg, there was highly statistically significant difference between both groups regarding IOP. Table (4), showed that the mean Spherical equivalent (SE) of the studied myopic group was -2.56± 1.6 D while among the studied hypermetropic group it was +3.35± 1.23 D , there was highly statistically significant difference between both groups regarding Spherical equivalent (SE). Table (5), showed that there was a statistical significant negative correlation between Spherical equivalent and IOP and AIOP (r=-0.728 and r=-0.499, P-value <0.05), regarding central corneal thickness, there was statistically significant negative correlation between AIOP and CCT(r=-0.419, p-value <0.05) but there was positive correlation between CCT and IOP(r=0.521, p-value<0.05). Table (6), showed that there is statistically significant positive correlation between Spherical equivalent and AIOP (r=0.447, P-value <0.05), regarding central corneal thickness, there was statistically significant negative correlation between AIOP and CCT(r=-0.681, p-value <0.05)but there was positive correlation between CCT and IOP(r=0.804, p-value <0.05).

Table (1): Demographic data of the studied groups.

Demographic data	Myopic patients		Hypermetropic patients		MWt/χ^2	p-value
	No.25	%	No.25	%		
Age (years)						
Mean ± SD	32.3± 5.61		35± 6.59		59.50	0.193 (NS)
Median (Range)	33(23-40)		38(20-40)			
Sex						
Male	10	38.5	12	46.2	Fisher's	1.000 (NS)
Female	15	61.5	13	53.8		

MWT: Mann- Whitney test

Chi-square test

P-value <0.05 is significant

S: Statistically significant

NS: Non significant

Table (2):Best Corrected Visual acuity (BCVA) among the studied eyes (N=50).

BCVA	Myopic eyes (N=25)		Hypermetropiceyes (N=25)		χ^2	p-value
	No.	%	No.	%		
1.0	22	88.0	22	88.0	0.667	0.717 (NS)
0.8	2	8.0	1	4.0		
0.6	1	4.0	2	8.0		

Chi-square test

P-value <0.05 is significant

NS: Non significant

Table (3): Intraocular pressure(IOP)among the studied eyes befor adjustment .

IOP	Myopic eyes (N=25)	Hypermetropiceyes (N=25)	MWt	p-value
Mean ± SD mmhg	17.44± 2.41	13.92± 1.8	84.000	0.000* (HS)
Median (Range)	18(12-20)	14(11-18)		

MWT: Mann- Whitney test

P-value <0.05 is significant

HS: highly significant

Table (4): Spherical equivalent (SE) among the studied eyes.

SE	Myopic eyes (N=25)	Hypermetropic eyes (N=25)	MWt	p-value
Mean ± SD (D)	-2.56± 1.6	3.35± 1.23	0.000	0.000* (HS)
Median (Range)	-2.25(-6.0-1.5)	+2.75(1.75-+5.75)		

MWT: Mann- Whitney test

P-value <0.05 is significant

HS: highly significant

Table (5): Correlation matrix between SE, IOP , AIOP and CCT among the studied myopic eyes.

Correlation Coefficient		SE	AIOP	IOP
AIOP	**R**	**-0.728****		
	p-value	**0.000**		
IOP	**R**	**-0.499***	**0.472***	
	p-value	**0.011**	**0.017**	
CCT	**R**	**0.099**	**-0.419***	**0.521****
	p-value	**0.638**	**0.037**	**0.008**

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

Table (6): Correlation matrix between SE, IOP, AIOP and CCT among the studied hypermetropic eyes.

Correlation Coefficient		SE	AIOP	IOP
AIOP	**R**	0.447*		
	p-value	0.025		
IOP	**R**	0.089	-0.201	
	p-value	0.674	0.336	
CCT	**R**	-0.134	-0.681**	0.804**
	p-value	0.524	0.000	0.000

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

IV. DISCUSSION

It is generally accepted that there is an increased prevalence of glaucoma among myopic eyes. Myopic eyes had a 1.6 to 3.3 times increased risk of glaucoma. One of the reasons as to why glaucoma should be more frequent in myopic eyes seems to be higher intraocular pressure (IOP) in myopic eyes compared with non-myopic eyes. This causal relationship can be rationalised by the knowledge that IOP is still considered an important risk factor for the development of glaucoma [11].

The Visual Impairment Project in Australia showed that the mean IOP among patients with newly developed glaucoma over a 5-year period was significantly higher than that among the non-incident cases. Furthermore, it has been suggested that myopic eyes are more susceptible to the effects of elevated IOP. It has been also proposed that myopic eyes have abnormal connective tissue that could predispose to glaucoma [12].

There is evidence from the literature that a correlation exists between refractive status and IOP [11]. Even after adjusting for age, sex, diabetes and blood pressure, mean IOP higher in myopic eyes compared with IOP was approximately 0.5 non-myopic eyes in the Blue Mountains Eye Study [13]. However, little is known about the true relationship between refractive status and IOP taking into account the central corneal thickness (CCT), as the CCT has a significant influence on IOP measurement.

As regarding our results, the study showed that the mean age of the studied myopic group was 32.3 ± 5.61 years old, with a range from 20 to 40 years old. And 38.5% of them were males, and 61.5 % were females, while mean age of the studied hypermetropic group was 35 ± 6.59 years old, with a range from 20 to 40 years old. And 46.2 % of them were males, and 53.8 % were females, there was no statistically significant difference

between both groups regarding sex and age. Which in agreement with the study of **Mourad et al. [14],** who reported that the mean age of all patients was 33.75±7.56 years. Regarding sex of the patients, 53.6% of patients were females, whereas 46.4% were males with no statistical significant difference between studied groups and study of **McGhee et al. [15]**, who found that hypermetropic patients who come to refractive surgery are older than myopic patients with a statistical significant difference.

The current study showed that among the studied myopic group BCVA was 1.0 in 88 % of the studied eyes also among the studied hypermetropic group BCVA was 1.0 in 88% of the studied eyes, with no statistically significant difference between both groups and among the studied myopic group VA was 0.33, 0.1 and 0.6 in 32%, 24% & 20% respectively while among the studied hypermetropic group VA was 0.3, 0.1 and 0.6 in 32%, 16% & 4% respectively, with no statistically significant difference between both groups. Which in agreement with the study of **Karthikeyan and Meenakshi [16],** who found that a final visual acuity of 0.8 or better was achieved by 51% (34/66) of myopic amblyopes and 52% (18/34) of hypermetropic amblyopes. Visual acuities of 0.6–0.4 were achieved in 34% (23/66) of myopes and 41% (14/34) of hyperopes. Final visual acuities of 0.3 were achieved in 13% (9/66) of myopes and 5% (2/34) of hypermetropes.

The current study showed that the mean IOP of the studied myopic group was 17.44 ± 2.41 mmhg . while among the studied hypermetropic group it was 13.92 ± 1.8 mmhg , there was highly statistically significant difference between both groups regarding IOP, which in agreement with the study of **Jarade et al., [17],** who reported that the mean IOP was 14.22 +/- 2.56 mmHg and 13.70 +/- 2.09 mmHg in the hyperopic and myopic groups respectively with a high significant difference (P < .001). also the study of **Osaiyuwu and Edokpa [18]**, who demonstrate that in the Nigerian population recently diagnosed with POAG, myopes had a higher mean intraocular pressure as compared to hypermetropes. The myopes also had a mean IOP value higher than normal when contrasted with hyperopes

The current study showed that the mean Spherical equivalent (SE) of the studied myopic group was -2.56 ± 1.6 D While among the studied hypermetropic group it was +3.35 ± 1.23 D , there was highly statistically significant difference between both groups regarding Spherical equivalent (SE), which in agreement with the study of **Iyamu et al. [19]**, who reported a high significant difference between myopic group and hypermetropic group.

The current study showed that there was statistically significant negative correlation between Spherical equivalent and IOP and AIOP (r=-0.728 and r=-0.499, P-value <0.05), regarding Central corneal thickness, there was statistically significant negative correlation between AIOP and CCT(r=-0.419, p-value <0.05) but there was positive correlation between CCT and IOP(r=0.521, p-value<0.05). There was in agreement with the study of **Wei et al., [6],** who found that the mean CCT and IOP were 554.19±35.46 μm and 15.31±2.57 mmHg respectively. There were significant correlations between the CCT and IOP values. Linear regression analysis revealed a positive correlation between CCT and IOP (r = 0.44, P<0.05).

This study showed that there is statistically significant positive correlation between spherical equivalent and AIOP (r=0.447, P-value <0.05), regarding central corneal thickness, there was statistically significant negative correlation between AIOP and CCT(r=-0.681, p-value <0.05) but there was positive correlation between CCT and IOP(r=0.804, p-value<0.05). Our findings are in agreement with the study of **Nomura et al.**

[20], who investigated the relationship between intraocular pressure (IOP) and refractive errors after adjusting for age, central corneal thickness (CCT), and other related factors.

There was positive correlation between IOP and increasing degrees of myopia [11]. Nevertheless, it has also been reported that no difference in IOP was detected between the two eyes in anisometropic subjects with unilateral myopia. Therefore, the relationship between IOP and myopia has been inconclusive. However, little or no evidence considering the influence of CCT on this relationship has been reported, although the influence of CCT on IOP measurement seems critical. The data reported here show that there is a positive significant association between IOP and advancing degrees of myopia, even after adjusting for CCT, and other relevant factors.

V. Conclusions:

The myopic refractive error and the intra-ocular pressure seem to have a significant correlation as such that with the increase of myopic refractive error there was increase of the intra-ocular pressure. This findings support the hypothesis that the relationship between glaucoma and myopia might be pressure mediated.

Recommendations:

Further studies with a larger number of sample size are recommended which can shed more light on the relation between refractive error and adjusted intraocular pressure . Performing other studies using additions of axial length to differentiate between refractive and axial refractive error and which type more correlated with IOP .

REFERENCES

1. **Avitabile T, Longo A, Rocca D, Amato R, Gagliano C, Castaing M.** The influence of refractive errors on IOP measurement by rebound tonometry (ICare) and Goldmann applanation tonometry. Graefes Arch Clin Exp Ophthalmol 2010; 248 (4) : 585-91.
2. **Han X, Yang T, Zhang J, Yu S, Guo X, Yan W. et al.** Longitudinal changes in intraocular pressure and association with systemic factors and refractive error: Lingtou Eye Cohort Study. BMJ open 2018; 8 (2): e019416.
3. **Sanaa AY, Elham R A.** Age, gender and refractive error association with intraocular pressure in healthy Saudi participants: A cross-sectional study. Saudi J Ophthalmol 2016; 30 (1): 44-48.
4. **Das P, Das R, Shrivastava P, Mondal A.** A clinical study on the correlation between axial length, intraocular pressure and central corneal thickness in myopic eyes. International Journal of Contemporary Medical Research 2016; 3, 1141-1144.
5. **Fern K, Manny R, Gwiazda J, Hyman L, Weise K, Marsh-Tootle W.** Intraocular pressure and central corneal thickness in the COMET cohort. Optom Vis Sci 2012; 89 (8): 1225-34.

6. **Wei W, Fan Z, Wang L, Li Z, Jiao W, Li Y.** Correlation analysis between central corneal thickness and intraocular pressure in juveniles in Northern China: the Jinan city eye study. PLoS On e 2014; 9(8): e104842

7. **Wang S, Melles R, Lin S.** The impact of central corneal thickness on the risk for glaucoma in a large multiethnic population. J Glaucoma 2014; 23 (9): 606–612..

8. **Jorge J, Rosado J, Diaz-Rey J, González-Méijome J.** Central corneal thickness and anterior chamber depth measurement by Sirius Scheimpflug tomography and ultrasound. Clin Ophthalmol 2013; 7:417–422.

9. **Shah S, Spedding C, Bhojwani R, Kwatz J, Henson D, Mcleod D.** Assessment of the diurnal variation in central corneal thickness and intraocular pressure for patients with suspected glaucoma. Ophthalomology 2000; 107 (6) :1191-1193.

10. **Natung T, Taye T, Lyngdoh L, Dkhar B, Hajong R**. Refractive errors among patients attending the ophthalmology department of a medical college in North-East India. J Family Med Prim Care 2017; 6 (3): 543.

11. **Wong T, Klein B, Klein R, Knudtson M, Lee K.** Refractive errors, intraocular pressure, and glaucoma in a white population. Ophthalmology 2003; 110 (1): 211-217.

12. **Mukesh B, McCarty C, Rait J, Taylor H.** Five-year incidence of open-angle glaucoma: the visual impairment project. Ophthalmology 2002; 109 (6) : 1047-1051.

13. **Mitchell P, Hourihan F, Sandbach J, Wang J.** The relationship between glaucoma and myopia: the Blue Mountains Eye Study. Ophthalmology 1999, 106(10): 2010-2015.

14. **Mourad M, Rayhan R, Moustafa M, Hassan A.** Correlation between central corneal thickness and axial errors of refraction. J Egypt Ophthalmol Soc 2019; 112(2): 52.

15. **McGhee C, Ormonde S, Kohnen T, Lawless M, Brahma A, Comaish, I.** The surgical correction of moderate hypermetropia: the management controversy. Br J Ophthalmol 2002, 86(7): 815-822.

16. **Karthikeyan B, Meenakshi S.** The results of treatment of anisomyopic and anisohypermetropic amblyopia. Int Ophthalmol 2009, 29(4): 231-7.

17. **Jarade E, Nader F, Tabbara K.** Intraocular pressure measurement after hyperopic and myopic LASIK. J Refract Surg 2005, 21(4), 408-410.

18. **Osaiyuwu A, Edokpa G.** A Comparative Study of Intra Ocular Pressure in Myopia and Hyperopia Among a Nigerian Population Just Diagnosed With Primary Open Angle Glaucoma in Benin City. Int J Res Med Sci 2018, 6: 2234-7.

19. **Iyamu E, Iyamu J, Amadasun G.** Central corneal thickness and axial length in an adult Nigerian population. J Optom 2013, 6 (3): 154-160.

20. **Nomura H, Ando F, Niino N, Shimokata H, Miyake Y.** The relationship between intraocular pressure and refractive error adjusting for age and central corneal thickness. Ophthalmic Physiol Opt 2004; 24(1): 41-45.