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Association of refractive errors with intraocular pressure and its relationship with age and gender

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Abstract

Background & Objectives: Glaucoma is one of the leading causes of blindness worldwide. Increased Intraocular Pressure (IOP) is a well-known and important risk factor for development of glaucoma. Refractive errors are one of the growing problems worldwide with myopia as the most common refractive error. The present study is conducted to analyze the correlation between IOP and refractive status of eye and also to study the influence of age and gender on IOP.

Methodology: 120 cases of refractive error (ametropic eyes) aged between 20 to 60 years, attending Ophthalmology OPD were selected. They were categorized into four groups as High myopia (power > -6D), Moderate myopia (-3D to -6D), Low myopia (<-3D) and hypermetropia(>+0.25D). 120 subjects with normal vision (emmetropic eyes) of same age group were selected as control group. Visual acuity was determined by Snellen's chart, refractive error diagnosed by retinoscopy. IOP was measured by applanation method (using Perkin's Tonometer).

Results: Student's t-test for comparison between two groups and one way ANOVA test for multiple group comparison was used in analysis of data. In the Correlation of refractive status and IOP, it is observed that in high myopic 'p' value is <0.001 which is highly significant indicating that high myopic are more prone for increased IOP. Also, a positive correlation was found between IOP & advancing age. There was no significant change in IOP between the males and females.

Interpretation & Conclusion: It is observed that as the degree of myopia increases, IOP increases and also advancing age increases IOP. The study supports the hypothesis that high myopia and advancing age are the important risk factor for development of ocular hypertension.

Keywords: IOP, Myopia, Age, Gender, Glaucoma, Perkin's Tonometer.

Introduction

When parallel rays of light strikes the physiologically normal eye they are refracted so as to converge upon the retina where they focus, forming a circle of least diffusion. When these ideal optical condition occur with the eyes in a state of rest that is without any accommodation the state of refraction is termed as emmetropia here the far point is at infinity. If in a state of rest of the eye the parallel rays are not focused on retina and do not form a circle of least diffusion, the eye is said to be in an *ametropic* state. The normal refractive power of an eye is about + 60 Diopters (D). There are three types of refractive error (ametropic condition): (a) Myopia (or short sightedness) wherein the principle focus is formed in front of the retina, (b) Hypermetropia (or long sightedness), the principle focus is formed behind the retina and (c) Astigmatism, the rays of light from more than one meridian are brought to focus at different points[1].

IOP is the tension exerted by the aqueous humour in the intraocular tissue as a result of balance between its production and drainage; abnormalities in the IOP of a given eye can results in dysfunction of the eye. The average normal IOP in a human eye is 15.5 mmHg (mean 16 ± 2.5 mmHg)[1,2]. Persistent rise in IOP of the eye leads to a complex condition called glaucoma that may damage the optic nerve and lead to progressive blindness. Glaucoma is the leading cause of blindness in people above 40 years.[3]

There is higher prevalence of glaucoma among myopic eyes than in any other refractive errors or emmetropic eyes.[4] The relative risk of open angle glaucoma is found to increase incrementally as refractive status shifts from hypermetropia to myopia, becoming three times greater for myopic of - 5D or more as compared with hypermetropics. Glaucoma in myopic subjects is said to be pressure mediated.[5,6]

Objectives

- To study the relationship between IOP and refractive error.
- To study IOP changes in advancing age.
- To study IOP changes in different genders.

Methodology

The present study was conducted in Navodaya Medical College and Hospital, Raichur, after getting clearance from the institutional human ethical committee. Subjects attending the Ophthalmology OPD were selected using simple random method.

120 subjects aged between 20 – 60 years of both genders included in the study group were non alcoholics, non-smokers, free from any other systemic

illness [non diabetic, non-hypertensive] and both eyes showing same refractive error correction. 120 healthy subjects aged between 20 – 60 years of both genders, with normal refractive status formed the control group.

After obtaining informed consent, the demographic details and the anthropometric parameters like height, weight and vital signs were recorded, followed by systemic examination to rule out any illness. Visual acuity for distant vision was measured by Snellen's chart and refractive error was evaluated by streak retinoscopy. IOP was measured by Perkins Tonometer (applanation method). The study group was further divided into four groups:

- High myopic - 30 subjects. (Refractive error more than -6D)
- Moderate myopic - 30 subjects. (Refractive error between -3D to -6D)
- Low myopic - 30 subjects. (Refractive error between -0.25 to -3D)
- Hypermetropia- 30 subjects. (Refractive error more than +0.25D)

Results

All results are expressed as mean ± SD, the statistical tool used are Student's t-test for comparison between two groups and one way ANOVA test (Analysis of variance) for multiple group comparison. 'p' value less than or equal to 0.001 is considered statistically very highly significant, p<0.01 highly significant, p<0.05 significant and p value >0.05 is insignificant.

Table 1: Comparison of IOP in Right Eye & Left Eye

Refractive status	IOP: Right Eye (mm of Hg)	IOP: Left Eye (mm of Hg)	p value
Control	14.78±1.65	14.86±1.63	>0.05
High myopia	18.0±2.4	18.08±2.48	>0.05
Moderate myopia	16±2	16±2.98	>0.05
Low myopia	15.28±2.03	15.12±1.92	>0.05
Hypermetropics	15.12±1.53	15.12±1.92	>0.05

No significant difference was noted between IOP in the right eye and left eye. Since there is no significant difference of IOP between right and left eye, only right eye readings are taken for statistical analysis to avoid confusion.

Table 2: Co-relation of Refractive Status and IOP

Refractive status	No	IOP (mm Hg)	t-test	p value
Emmetropia (Control)	120	14.78±1.65		
High myopia	30	18.00±2.4	5.67	<0.01***
Moderate myopia	30	16±2	0.95	>0.05
Low myopia	30	15.28±2.03	0.65	>0.05
Hypermetropics	30	15.12±1.53	0.82	>0.05

***Highly significant, indicating that high myopic are more prone for increased IOP.

Table 3: Correlation of IOP with Refractive Errors

Refractive Error	No	Mean±SD
High myopia	30	18.0±2.4***
Moderate myopia	30	16±2
Low myopia	30	15.28±2.03
Hypermetropics	30	15.12±1.53

*** Highly significant. **ANOVA test** showed that there is highly significant association of mean IOP in high myopia compared to other groups of refractive errors.

Table 4: Correlation of IOP with Age

Groups	Age(years)	IOP Mean ± SD	p Value
Control	20-40	14.33±1.65	<0.01
	40-60	15.27±1.24	
High myopics	20-40	16.85±3.2	<0.01
	40-60	18.33±2	
Moderate myopia	20-40	16.01±5.04	<0.01
	40-60	17.98±2.25	
Low myopia	20-40	14.05±2.04	<0.01
	40-60	15.88±2.35	
Hypermetropia	20-40	14.00±1.92	<0.01
	40-60	15.53±1.72	

In all the groups there is significant difference of IOP with respect to age (P value <0.01).

Table 5: Gender distribution of cases and control

Refractive Status	Males	%	Females	%	Total
Control	60	50%	60	50%	120
High myopia	15	50%	15	50%	30
Moderate myopia	15	50%	15	50%	30
Low myopia	15	50%	15	50%	30
Hypermetropia	15	50%	15	50%	30
Total	120	50%	120	50%	30

The percentages of distribution of control and cases were equal among males and females.

Table 6: Correlation of IOP with gender

Refractive Error	Gender	IOP Mean±SD	p Value
Controls	M	14.43±1.63	>0.05
	F	14.23±1.75	
High myopics	M	18.25±3.2	>0.05
	F	18.33±2.12	
Moderate myopia	M	16.15±2.04	>0.05
	F	16.00±2.25	
Low myopia	M	15.25±2.04	>0.05
	F	15.18±2.35	
Hypermetropia	M	14.98±1.92	>0.05

	F	14.23±1.72	

In all the groups there is no significant difference of IOP with respect to gender.

Discussion

Refractive errors are very common ocular problems in the population worldwide. Myopia is one of the risk factors for glaucoma that is commonly mentioned in various studies. Study done by Abdalla MI *et al* showed high IOP in myopic individuals compared to non-myopic individuals suggesting that relationship between glaucoma and myopia may be pressure mediated[7]. In large case control study, myopia was found to be strongly associated with ocular hypertension. It has been observed that about 30% of subjects with primary open angle glaucoma can be expected to be myopic, which is about three times the incidence in a normal population of same age group.[8]

The main purpose of this study is to find the relationship between the refractive errors and IOP and to conform whether myopia, age and gender could be important risk factor for ocular hypertension. Our results were similar to the results obtained by Davanger M *et al*, that IOP in right eye and left eye had no significant difference.[9] In our study we found statistically highly significant difference in IOP among high myopics compared to other groups. Similar results were obtained by various other studies[10,11,12,13]. However, some studies also showed significant difference in IOP among moderate myopics[14,15,16], which was not seen in the present study.

The possible mechanism for raised IOP in myopics is the shearing forces exerted by scleral tension across the lamina cribriosa and may be important in pathogenesis of pressure damage[17]. Myopic eyes have higher scleral tension across the lamina than in the eyes with shorter axial length, even when IOP measured is same[18]. High myopia is more likely to be steroid responders than those in general community, the gene coding for trabecular meshwork induced glucocorticoids response protein in the GLCIA locus on chromosome 1q21-q31 was identified and found in 3.9% of a glaucoma population compared to 0.3% of general population. It is possible that this and other glaucoma genes may be represented more frequently in persons with myopia[19].

Lee. A.J *et al* stated that glaucoma remains the important link between myopia and IOP in adults, increased IOP is an important risk factor, but is not synonymous with glaucoma.[20] In myopic eyes the ciliary body is in relatively posterior position, in relation to canal of Schlemm so that it has less mechanical advantage in widening the spaces in the trabecular meshwork during accommodation[21]. Fluorescein angiographic studies have suggested a reduced choroidal blood flow in myopes, and the amplitude of the ocular pulse is lower in myopes than in emmetropes or hypermetropes. The circulation to optic disc in myopic eye is also reduced and therefore myopics are more susceptible to raised IOP[13].

In the present study, IOP was statistically significant with age in both males and females. Older age has been reported as a risk factor for the development of glaucoma in patient with ocular hypertension in multiple progression studies[22]. Several population based studies have found that the incidence of open angle glaucoma increases with older age groups. Also there is strong evidence that older age is an independent risk factor for the progression of ocular hypertension and glaucoma[23]. In many cross sectional and follow-up studies, the incidence of raised IOP, ocular hypertension and glaucoma showed a sharp increase with age[24,25].

In elderly individuals the onset of structural changes in trabecular meshwork results in reduction in trabecular outflow facility and uveoscleral outflow and hence elevated IOP[26,27]. Aging is associated with modest elevation of IOP and is also linked to progressive decline in cerebral and ocular perfusion. Older patients with glaucoma may have dysfunction of ocular blood flow auto regulation or have elevated IOP which corresponds to damage of the optic nerve. Other possible risk factors for development of ocular hypertension or glaucoma in older age are: low intracranial pressure, local vasospasm, autoimmune disorder, sleep apnea, inherited or acquired abnormalities of the connective tissue of the lamina cribrosa, primary ganglion cell degeneration, systemic hypertension and atherosclerosis[28]. Increased age may reflect the cumulative effects of some other factors that cause the aging optic nerve head to be more vulnerable to elevated IOP and even sometimes to normal range of IOP.[29]

Our study showed no correlation between gender and IOP. The results are quite similar to those obtained by other studies that did not support a gender-related IOP relationship.[30,31] However; a gender related difference in mean IOP has been reported in several studies.[32, 33]

Conclusion

By the present study we conclude that, a significant increase in the IOP in high myopics(>-6D) in comparison to emmetropic, moderate myopic, low myopic and Hypermetropics, indicating myopia as an important risk factor for ocular hypertension. Additionally, we found that the association between refractive error and IOP differs according to age. The recommendations of the present study are as follows:

- Considering myopia as an important major risk factor for glaucoma, myopics are recommended for eye checkup at regular intervals for refractive correction.
- Children of parents with myopic eye are advised to pay special attention and refractive errors to be screened and corrected, as they are also in risk

factor for development of glaucoma due to genetic back ground.

- Advancing age leads to increased IOP, hence age groups of above 40yrs are at higher risk, and are advised to monitor IOP at regular intervals.

Bibliography

1. Parson's diseases of eyes. Text book of Ophthalmology; 20th edition; 51-71.
2. Duke-Elder. "Phasic variation in the ocular tension in primary glaucoma". Amer Ophthal. 1952;35.
3. Becker Shaffer's. Diagnosis and therapy of glaucoma; 7th Edition: 1999; 20-26.
4. Xu L, Wang Y, Wang S, Wang Y, Jonas JB: "High myopia and glaucoma susceptibility the Beijing eye study" Arch ophthalmology 2007;114(2);216-220.
5. Mitchell P, Hourihan F, Sandbach J, and Wang JJ "The relationship between glaucoma and myopia: the Blue Mountains eye study. Arch ophthalmology; 2000;107(6);1026-1027.
6. Jain IS, Chaudhry J. "IOP dynamics in different RE". Indian journal of Ophthalmology. 1974;22(1);15-20.
7. Abdullah M.I, Hamdi M: Applanation ocular tension in myopia and emmetropia, Br. J, Ophthalmology 1970;54;122-125.
8. Edward S Perkins, Charles Phelps: Open angle glaucoma, ocular hypertension, low tension glaucoma and refraction. Arch ophthalmology 1982;100(9);1464-1467.
9. Davanger M: The statistical distribution of intra ocular pressure in the population, Acta Ophthalmol 1955;43;314.
10. Robert David, Linda M; Zangwill, Tessler, Yuval Yassur: The correlation between intra ocular pressure and refraction. Arch ophthalmology;1985;103;1812-5.
11. Grodum K, Heijl A, Bengtsson: Refractive error and glaucoma. Arch ophthalmology 2001;79(6);560-566.
12. Seddon JM, Schwartz B, and Flowerdew G: Case-Control study of ocular hypertension. Arch ophthalmology 1983;101;891.
13. Edward S Perkins, Charles Phelps: Open angle glaucoma, ocular hypertension, low tension glaucoma and refraction. Arch ophthalmology 1982;100(9);1464-1467.
14. Hiedeki Nomura, Fujiko Ando, Naoakira, Hiroshi Shimokata, Yozo Miyakeet: The relationship between intra ocular pressure and refractive error adjusting for age and corneal thickness, Ophthal, Physiol. Opt, 2004;24;41-45.
15. Hanne Jensen: Ocular hypertension; Documenta Ophthalmologica; 1992;82(3);249-255.
16. Tien Yin Wong, Barbara E, Klein, Ronald Klein, Michael, Kristine E: Refractive error, IOP and glaucoma in white population, ophthalmology 2003;110;211-217.
17. Quigley HA. Reappraisal of the mechanism of glaucomatous optic nerve damage. Eye 1987;1:318-22.
18. Cahane M, Bartove E, Axial length and scleral thickness effect on susceptibility to glaucomatous damage: a theoretical model implementing Laplace's law. Ophthalmic Resb1992;24:280-4.
19. Pojda S.M, Pojda Wilczek D, Herba E, Plech AR, Jedrzejewski. IOP of myopic patients suspected of glaucoma, 99 Jahrestagung, 2001;1.
20. Lee A J, Saw, Gazzard, A cheng, T H Tan: IOP associate with refractive error, Br Jr of ophthalmology 2004;88(1);5-7.
21. Nesteov A, Bervin A et al: IOP. Moscow, MRI Publisher,19722.
22. Gordon MO, Beiscr JA, Brandt JD, Heuer DK, Higginbotham EJ, Johnson CA et al. The ocular hypertension treatment study. Arch Ophthalmol 2002 Jun; 120: 714-20.
23. Friedman BS, Wilson MR, Liebmall JM, Fechtner RD, Weinreb RN. Anevidence – based assessment of risk factors for the progression of ocular hypertension and glaucoma. Am J Ophthalmol 2004 Sept; 138 suppl: S19-31.
24. Hart WM, Yablonski M, Kass MA, Becker B. Multivariate analysis of the risk of glaucomatous visual field loss. Arch Ophthalmol 1979 Aug; 97:1455-8.
25. Hiller R, Sperduto RD, Krueger DE. Race, iris pigmentation and IOP. Am J Epidemiol 1982;115(5):674-83.
26. Nemesure B, Hennis A, Wu SY, Leske MC. Factors related to the 4 – year risk of high IOP. Arch Ophthalmol 2003 Jun; 121:856-62.
27. Carol TB, Scott KA, Michael YE, Carl CB. Aqueous humor dynamics in ocular hypertensive patients. J Glaucoma 2002 Jun;11(3):253-8.
28. Harris A, Rechtman E, Siesky B, Cuypers CJ, McCranorl, Garzozi HJ. The role of optic nerve blood flow in the pathogenesis of glaucoma. Ophthalmol Clin N Am 2005;18:345-53.
29. Jacob A, Thomas R, Koshi SP, Braganza A, Muliyil J. Prevalence of primary glaucoma in an urban south – Indian population. Indian J Ophthalmol 1998;46:81-6.
30. Kahn HA, Leibowitz HM, Ganley JP, Kini MM, Colton T, Nickerson RS, et al. The Framingham eye study. I. Outline and major prevalence findings. Am J Epidemiol 1977;106(1):17–32.
31. Klein BEK, Klein R, Linton KLP. IOP in an American community: the Beaver Dam eye study. Invest Ophthalmol Vis Sci 1992;33(7):2224–8.
32. Armaly MF. On the distribution of applanation pressure: I. Statistical features and the effect of age, sex, and family history of glaucoma. Arch Ophthalmol 1965;73(1):11–8.
33. Bankes JL, Perkins ES, Tsolakis S, Wright JE. Bedford glaucoma survey. Br Med J 1968;1(595):791–6.e Tehran eye study. Br J Ophthalmol 2005;89(6):652–7.