Original Paper

Prevalence and Patterns of Astigmatic Refractive Errors in a Sample of Normal Iraqi Adults

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Abstract

Background: Astigmatism is an important clinical and public health issue, it is one of major refractive errors affecting population, persistent astigmatism will cause ametropia and reduced visual acuity by prohibiting the formation of a clear image on the retina which will result in poor work performance.

Subjects and Methods: In a cross-sectional study conducted in Ibn Al-Haitham teaching eye hospital from 10th of January 2017 to 20th of August 2018, volunteers with best corrected visual acuity of 6/6 were investigated. Evaluation of visual acuity, refraction, slit lamp bio microscopy and fundoscopy were performed for each participant. Written informed consent was obtained from all participants. Only phakic eye that could be reliably refracted without a previous history of ocular surgery were included. Data were collected and analysed using multiple logistic regression models, *p* value of less than 0.05% was considered statistically significant

Results: 400 eyes of 200 participants were investigated in this study of whom 53.5% were males, as shown in table 1.
 The prevalence of astigmatism was 34.25%.
Astigmatism significantly increased from 11.5 % in the participants of 18-22 years old to 60% in the participants over 58-years old (P < 0.001), as shown in table 2. The prevalence of With-The-Rule, Against-The-Rule, and Oblique astigmatism was 11.7%, 20.3% and 2.25%, respectively. Against-The-Rule significantly increased with age (P < 0.001). The mean corneal astigmatism was 0.73 D which linearly increased with age (P < 0.001).

Conclusion: In conclusion, 34.25% of our sample was having astigmatism according to the definition in this study, which means astigmatism is a common issue in our society. This study found that against the rule astigmatism increase with age.

key words: Against the rule astigmatism (ATR), Oblique astigmatism (OBL), With the rule astigmatism (WTR)

Introduction

The term astigmatism (from a, signifying "privative" or "lacking" and, stigma signifying "a point") was recommended by Dr. William Whewell (1794-1866), Master of Trinity College, Cambridge [1].
Astigmatism simply is a description of an optical condition in which light rays from a certain source come to focus to different points, due to variations in the corneal or the lenticular curvatures at different meridians. Instead of forming a single focal point on the retina, there is two sets of focal lines [,2,3,4,5].

The occurrence of astigmatism has been documented in 8% to 10% of adults. However, wide variation in the prevalence has been noticed ranging from 30% among old people in Myanmar to 77% in Indonesia [6,7,8,9,10,11].

Astigmatism is the commonest refractive error in certain areas such as Indonesia, [6] Taiwan, [8] and Japan, [11] affecting approximately half of the people in these countries.

However, the documented prevalence of astigmatism differs quietly in different studies, these studies showed that astigmatism is influenced by many factors such as the age, gender, geography, ethnicity ,time, diet, personality, systemic diseases, ocular disease), and the various definitions of astigmatism, and methods used in refraction.[9] the severity of Astigmatism was defined as a cylinder power of 0.5 D and more, as shown in table 2.

For investigating astigmatism, its prevalence was documented based on the cylinder power of 0.5-1,>1-2,> 2-3 and> 3, (as shown in table 3).

The astigmatism axis was classified as *WTR(with the rule astigmatism)* if the steep axis was at 90º (±20º) and the correcting minus cylinder was at 180º (±20º) or correcting plus cylinder at 90º (±20º), *ATR* (against the rule astigmatism) if the steep axis was at 180º (±20º) and the correcting minus cylinder was at 90º (±20º) or correcting plus cylinder at 180º (±20º), and *OBL* (oblique astigmatism) if it was at any other meridian.

Keratometry results were used to calculate corneal astigmatism. which was the difference between maximum and minimum keratometry.

Objectives of the study

In this study our aim is to determine the prevalence of astigmatism, the astigmatic axis, and to investigate the differences in types and magnitude of astigmatism among different age groups and gender in a sample of normal Iraqi adults.

Subjects and methods

In this cross-sectional study, Iraqi adults aged 18 years and older with best corrected visual acuity of 6/6 who attending Ibn Al-Haitham teaching eye hospital were the target in this study. 400 eyes of 200 participants were examined in our hospital from 10th of January 2017 to 20th of August2018.

volunteers attending Ibn Al-Haitham teaching eye hospital with phakic eyes with best corrected visual acuity of 6/6 were included, while individuals with history of trauma, glaucoma, pterygium, ocular surgery, contact lens wear and people with external eye disease such as chalazion and vernal diseases were excluded from the study.

An interview on the demographic characteristics (name, age, gender, occupation, address), past ocular history, medical and surgical history, drug history and social history were done for each participant in this study.

The site for optometric examinations had standard illumination. The first step in our examination protocol was performing visual acuity assessment at a distance of 6 meters with (illiterate E chart), if visual acuity was less than 6/6 then an auto-refraction and keratometry-reading with the Topcon (KR-8000) auto refractor done for each eye, average of 6 readings were taken for each eye. The right eye of each subject was tested first followed by the left eye.

The results of auto refraction were used as a basis for the next step which is full subjective refraction. To verify the accuracy of auto-refraction, non-cycloplegic refraction using retinoscope (Welch Allyn 18245 Elite Streak Retinoscope) with trial lenses (OCULUS Trial Cases BK) was performed at a distance of 2/3 meters. Ophthalmic examinations were performed after optometric examinations.

(Slit Lamp; Haag-Streit, Koeniz, Switzerland), *IOP*, and assessment of anterior and posterior segment of each eye without dilatation.

The prevalence of total and corneal astigmatism has been calculated using *Microsoft Excel* software.

A multiple logistic regression models have been used to investigate the relationship of astigmatism with age and gender. In this study, astigmatism with cylinder power of 0.5 D and more was defined as the dependent variable. Multiple logistic regression was performed to investigate all variables.

A (*P*)value of less than 0.05 was considered statistically significant.

Results

Four hundred eyes of two hundred participant were included in this study, of which there were 107 males (214 eyes) (53.5%); and 93 females (186 eyes) (46.5%), as shown in table 1.

The mean (± standard deviation) of age was 37.85(±11.9) years old, (range was 18 to 65 years).

The sample divided according to statistical analysis into nine groups as shown in table 1.

The prevalence of astigmatism shows significant increment with age (p value <0.05) as shown in Table 2. The prevalence of astigmatism was 11.5 % in the participants of 18-22 years old and increased significantly up to 60 % in the participants over 58 years old; therefore, each 1-year increase in age increased the likelihood of astigmatism by 1.07 times *(P < 0.001)*.

According to the results of this study, the prevalence of astigmatism with cylinder power more than 1, 2 and 3 D was 8.6%, 2%, and 1.4%, respectively, as shown in table 3.

The prevalence of astigmatism in the right eye was 35.75% (95% CI: 32.42-38.35) and in the left eye was 33.75% (95% CI: 30.34-36.27) regression analysis also didn't show significant difference in the prevalence of astigmatism between right and left eyes (*p= 0.511*).

Table 1. age groups

age	no. of eyes	Percentage %
18-22	52	13
23-27	50	12.5
28-32	50	12.5
33-37	46	11.5
38-42	62	15.5
43-47	40	10.5
48-52	44	11
53-57	36	9
58 and more	20	5
females	186	46.5
Males	214	53.5
Total	400	100

Table 2. prevalence of astigmatism in age group

prevalence of astigmatism in age groups		
Age in years	Number of eyes with Astigmatism of 0.5 D and more	Percentage
18-22	6	11.5
23-27	6	12
28-32	12	24
33-37	13	28.2
38-42	26	41.9
43-47	19	47.5
48-52	23	52.2
53-57	20	55
58 and zmore	12	60
Female	66	35.48
Male	71	33.17
total	137	34.25

Table 3. severity of astigmatism

severity of astigmatism with age					
Age in years	>0.5-1 D	>1-2 D	>2-3 D	3D and more	Total percentage
18-23	8.2	2.2	0.7	0.4	11.5
24-28	8.6	2.1	0.9	0.4	12
29-33	14.1	7.5	1.7	0.7	24
34-38	15.9	8.5	2.3	1.5	28.2
39-43	24.3	9.8	5.6	2.2	41.9
44-48	26.6	11.1	6.9	2.9	47.5
49-53	28.4	13.6	7.1	3.1	52.2
54-58	29	13.8	7.7	4.5	55
59 and more	32	15	8	5	60
Total	22.25	8.6	2	1.4	34.25

To classify astigmatism into myopic and hyperopic, we took only the cylinder and ignore the sphere. Myopic astigmatism was the most prevalent type 75.3% while hyperopic astigmatism was 24.7%, this ratio was approximately identical in males (75% myopic and 25% hyperopic) and females (73.4% myopic and 26.6% hyperopic) ; myopic astigmatism was the most prevalent in all age groups , the difference in the prevalence among different age groups was statistically insignificant ($p = 0.629$) .

The prevalence of WTR, ATR and OBL astigmatism was 11.7%, 20.3% and 2.25% respectively.

The prevalence of different types of astigmatism showed significant changes with age ($P<0.001$) as shown in table 5 and chart 3. The greatest variation of astigmatism with age was seen in ATR. This type of astigmatism increased from 4.6 % in participants with age of 18-22 years to 42.8 % in participants over 58 years of age which was statistically significant ($P < 0.001$).

However, there was no significant difference in astigmatic change between males and females (P=0.632 chi square test.

Discussion

To our knowledge, this the first study that investigated the prevalence of different patterns of astigmatism in a sample of Iraqi population. Additionally, only few studies have focused on the prevalence of astigmatism in different age groups. The prevalence of astigmatism with the cylinder power greater than 0.5 D was 34.25%.

The prevalence of astigmatism did not show a significant difference between genders in different age groups *(p= 0.257),* which was similar to results that have been reported in the literature. For example, Sawada *et al*.,[11] in Japan, Wong *et al*.,[12] among the Chinese living in Singapore, Krishnaiah *et al*.,[13] in India, Gupta *et al*.,[14] in Myanmar, Cheng *et al*. [8], in Taiwan and Saw *et al*.,[15] in Singapore did not report any differences in the prevalence of astigmatism between the males and

females. In contradiction, some reports from Beijing [16] and Bangladesh [17] have shown the prevalence of astigmatism was higher among females than males. However, Nangia *et al*., [18] in India, and Saw *et al*.,[15] in Singapore, reported the prevalence of astigmatism was higher in males when compared to females. Myopic astigmatism was the most prevalent type among different age groups 75.3% compared to hyperopic astigmatism 24.7%, this finding may be explained by the fact of myopic shift that increase with increasing age.

This study found that ATR astigmatism was 20.3% which is the most frequent type compared to WTR astigmatism 11.7% and oblique astigmatism 2.25%. the prevalence of ATR astigmatism significantly increased with age (from 4.6 % in participants with age of 18-22 years to 42.8 % in participants over 58 years of age ($P < 0.001$)). Previous studies have also shown that ATR astigmatism increases with age [19]

Variations of astigmatism with age show that WTR astigmatism was slightly more prevalent than ATR in 18-22 years age group (6.2% WTR vs. 4.6% ATR). Then, ATR start to become more prevalent in 28-32 years age group (8.6% for WTR vs. 12.06% for ATR). In 58 years and older, ATR became significantly higher than WTR. this change in astigmatism can be explained by the fact that weakness of *levatore palpebrae superioris* muscle which occur with age will lead to decrease in eyelid pressure over cornea, actually, this is one of the most important factors that change the type of astigmatism with age. This finding has been confirmed in previous studies [19]. The mean corneal astigmatism started to increase from 0.53D in participants (18-22 years) to reach 1.75D in participants older than 58 years, as shown in table 2, in such a way that the difference in corneal astigmatism was 1.22 D. This finding supported the previous hypothesis concerning the effect of environmental factors on the cornea. This finding was also compatible with the findings of Asano *et al*., and Asgari, who

reported that changes in astigmatism at an older age are mostly due to corneal factors [20,21]

The axis of corneal astigmatism was similar to total astigmatism. The increase in ATR astigmatism and decrease in WTR astigmatism with age were more significant than the change in total astigmatism [22,23].

One of the biggest limitations of this study is limited number of participants, poor investigation of environmental factors and limited age groups, in addition, non-cycloplegic refraction values were based on the mean of 6 auto refractor readings and did not include subjective refinement. This may have resulted in overestimates of the true number with astigmatism. In addition, many participants with irregular astigmatism didn't show reliable results using auto refraction, so they were excluded from the study

Recommendations

Cross-sectional data are not predictive of the longitudinal behaviour of individuals. So, in recommendations, Population-based longitudinal studies are required to further clarify age related trends in astigmatism, another study with larger sample and more variation in age of participants is suggested. Measurement of irregular astigmatism using auto refraction alone was not so accurate, for which it need to be investigated more deeply in future studies, also any person discovered to have frequently increased astigmatism specially those between the ages 11 and 30 must be sent for further ophthalmic investigations to exclude keratoconus which is not un common in our society, media could be used to help in this issue too.

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