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Change in corneal astigmatism with age

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HIGHLIGHTS

Corneal astigmatism is common in all age groups and changes over time, so it is important to monitor its progression or regression to ensure optimal correction or treatment.

ABSTRACT

The work is theoretical in nature and was created to test the relationship between age and changes in astigmatism. The analysis was carried out on the basis of the available studies described in the literature on the subject. The collected statistical data and medical information allow for the conclusion that astigmatism may change with age. The implemented project presents results that have both cognitive and application value. The identified bindings can be used in the medical practice of patients with astigmatism.

Key words: corneal astigmatism, change, eye changes with age

INTRODUCTION

Astigmatism is an abnormality in the functioning of the optical system of the eye and consists in the different strength of the refraction of parallel light rays in different planes of the optical system of the eye. Consequently, there is no single point focusing the beams of light rays, with the result that the image on the retina is not well focused. Instead, the rays are focused unevenly at several points on the retina and this results in blurred vision both near and far. Depending on which eye structure is abnormal (incoherent), there are different types of astigmatism. The most common is corneal astigmatism, which is the result of an abnormal shape of the cornea. Usually it is straight, less often oblique or inverse. Astigmatism can be caused by genetic as well as environmental factors. There is a lot of research into the genetic factors that influence the development of astigmatism. Hammond et al., in their studies on the relative importance of genes and the environment in refractive error, concluded that the dominant genes appear to be important in the inheritance of astigmatism, with a slightly lower overall genetic component of about 50% for astigmatism total and up to 60% for corneal astigmatism [1].

CHANGE IN CORNEAL ASTIGMATISM WITH AGE IN CHILDREN

The prevalence of astigmatism with a minimum of 1 D varies from 30% in the neonatal period to 50% in infancy. It peaks at 60% between the ages of 1.5–2.5 years and decreases to 20–40% in children aged 5 years. The prevalence of incontinence decreases in older school-aged children to about 12–13% [2].

High values of astigmatism are found in infancy, mainly against the rule (ATR, against the rule), because the cornea has a steeper shape than in older children. Poor eyelid tension is also an important factor, which, among other things, was the subject of research by a team of Cambridge ophthalmologists. A study by the aforementioned involving 1,000 children in the age range from birth to age 6 showed that many cases of diagnosed astigmatism detected before age 2 are subject to significant reduction or elimination by age 4. The majority of children before the age of 4.5 years have non-compliant astigmatism and after that age have compliant astigmatism. The higher prevalence of astigmatism in infancy and rarer in school-aged children means that much of the early astigmatism is eliminated between the ages of 1 and 6. Because infants tend to have non-conforming astigmatism and older children have con-forming astigmatism, changes in the astigmatism axis must also occur during this time.

Most studies performed in groups of school-aged children indicate a low prevalence of clinically relevant astigmatism. In most cases, it is astigmatism that follows the rule. Based on long-term observations, it can be concluded that a child who does not have astigmatism in infancy is unlikely to acquire it at a later age, at least until the age of 4–6. [3]. Studies over the past few years have provided an extensive database of refractive change in children of the Tohono O'odham tribe of Indians, who are found to have a high prevalence of astigmatism at school age. It is due to abnormal corneal structure and almost always follows the rule [4]. A longterm study of corneal astigmatism in 960 Tohono O'odham children aged 6 months to 7 years showed that during early development (6 months to < 3 years), astigmatism decreased in children with high astigmatism (by -0.37 D/year) and remained stable in children with little or no astigmatism (+0.05 D/year). Between the ages of 3 and 7, astigmatism decreased in children with both high (by -0.11 D/year) and low astigmatism or no astigmatism (by -0.03 D/year). Data collected later on children over the age of 7 suggested that younger children with high astigma-tism and children over the age of 11 showed a tendency for astigmatism to increase with age. However, all of the average changes observed were small and not clinically significant [5].

A study of the changing profile of astigmatism in school-aged children in Northern Ireland also found that this refractive defect does not remain constant throughout childhood. Data from Phase 1 of the Northern Ireland Childhood Errors of Refraction (NICER), a population-based study of the prevalence of refractive error in white school-aged children, showed a similarly high frequency of astigmatism in children aged 6–7 and 12–13. Astigmatism values of 1 D or more were significantly associated with myopia and hyperopia.

These cross-sectional data do not allow an assessment of how the presence of astigmatism in childhood affects the subsequent development of ametropia. Prospective studies have provided inconclusive results: astigmatism has been shown to be associated with the development of myopia in childhood and its progression, but also that the progression of myopia during the first 3 years is unrelated to the magnitude of lower values of astigmatism (≤ 2 D). Compared to the large amount of data available on how refractive parameters such as spherical defects change with age, we have too little information on the changing profile of individual astigmatism during the school years, and it is currently unclear whether astigmatism is a cause or effect of ametropia. Few studies, with the exception of surveys in non-white populations, have looked at the prevalence of astigmatism in childhood over the age of 12–13. The current study confirms that the prevalence of astigmatism remains relatively constant both during childhood and after 12–13 years of follow-up. However, the above prevalence data are incon-

clusive, as the results of this study showed that a notable minority of astigmatic profiles of individuals are dynamic during this period. This finding has important public health implications, as the changing profile of astigmatism in childhood should be taken into account when making recommendations for appropriate eye examination intervals, as uncorrected astigmatism can cause significant deterioration in visual function [6].

CHANGE IN CORNEAL ASTIGMATISM WITH AGE IN ADULTS AND THE ELDERLY

Astigmatism is usually caused by the non-spherical shape of the central area of the cornea, and much less often is associated with an abnormal shape of the lens or the posterior pole of the eye, or the coexistence of improper lens structure and deformation of the cornea. With age, there is a general change in the axis of astigmatism with a predominance of astigmatism consistent with the rule in young adults to a predominance of ATR astigmatism in adults over 40 years of age. In early adolescence, astigmatism usually does not exceed 1.0 D. In their studies, Fledelius and Stubgaard showed that in younger adults, in the range of 20 to 40 years of age, astigmatism is quite frequent and its values are low. Astigmatism in these people is characterized by the orientation of the axis of the cylinder according to the rule. However, in adults after 40 years of age the corneas are steeper in the horizontal section, which contributes to the more frequent occurrence of ATR astigmatism [7].

Næser et al., on the basis of research on changes in corneal astigmatism, including oblique, age-related concluded that corneal astigmatism is stable until the age of 50, and then changes against the rule by 0.25 D out of 10 years. The average 0.25 D ATR PCA (posterior corneal astigmatism), which remains stable in all age groups, compensates for dominant keratometric astigmatism according to the rule (WTR) in younger patients and increases TCA (total corneal astigmatism) in the elderly with ATR keratometric astigmatism [8].

Astigmatism is a common refractive disorder in clinical practice. Sanfilippo et al., in studies whose main aim was to assess the relationship between astigmatism and age in the Australian population, showed the relative stability of total astigmatism up to the 5th decade of life, and then its increase with age. The information obtained in the studies was crucial for further analyzes of environmental and genetic factors influencing astigmatism [9]. The literature on the subject contains numerous research results, the aim of which was to check the correlation between the change in astigmatism and old age. These studies confirmed that the incidence of astigmatism increases with the age of patients. The axis of astigma-tism shifts from simple astigmatism (WTR) to reverse astigmatism, or ATR. The studies also showed age-related changes in the geometry of the cornea. The anterior appearance of the cornea at the 90° and 270° axes decreased, and those at the 0° and 180° axes increased with age in linear regression analyzes and showed horizontal tilt and vertical flattening of the corneal surface. However, the studies did not show any significant age--related differences in the posterior elevations and pachymetry results, including the central corneal thickness [10]. A correlation study was also performed between the topography of the cornea and the width of the palpebral fissure. It showed that decreased eyelid tension caused by dermatochalase, i.e. the accumulation of excess eyelid skin associated with age, may affect the geometry of the cornea [11]. In 2017, studies were conducted to show the correlation between the occurrence of corneal astigmatism in people over 50 years of age. and cataracts. They showed that most cataract patients over 50 years of age has astigmatism > 0.75 before cataract surgery. When the axial length of the eye is between 22.00 mm and 25.99 mm, the severity of corneal astigmatism increases with age over 65 years, especially the severity of ATR corneal astigmatism, while the severity of WTR corneal astigmatism does not increase with age. The amount of ATR astigmatism increases, while the WTR level decreases [12]. Moreover, it has been confirmed that with age, the incidence of cataracts increases in the elderly, which also affects refraction changes [8]. There are many factors that influence astigmatism. Therefore, the correlation between age and gender should also be taken into account. Correlations between astigmatism in various age groups (40–49 years, 50–59 years, 60–69, 70–79 and ≥ 80 years) and gender were investigated. The changes that were observed concerned only the anterior shape of the cornea. The posterior shape of the cornea remained unchanged in both sexes and in all age groups. Across all age groups, the horizontal and vertical axis components for total and anterior surface of the cornea were significantly lower in men than in women, indicating that non-ATR astigmatism is greater in men. Using videokeratographic maps, it has been noticed that the overall and anterior shape of the cornea change with age in both sexes. Studies have shown that the ATR change begins at a younger age in men than in women [13].

CONCLUSIONS

Astigmatism is a common refractive error and can change with age. The most common cause of astigmatism is abnormal curvature of the cornea. Based on numerous research results, the conclusion was drawn that in the early stage of development, infants develop non-compliant

astigmatism, while in older schoolchildren, astigmatism compliant with the rule is observed. With age, there is a shift from astigmatism that is consistent with the rule in young adults to predominance of astigmatism over the rule in adults over 40 years of age. In the elderly, there are changes in the geometry of the cornea, which contribute to the much more frequent incidence of astigmatism against the rule in this age group.

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