

# Comparison of Anterior Corneal Astigmatism with Total Refractive Astigmatism

Ambika Singh,Rajeev Trivedi,Kritika  
Galgotias Univerity,Yamuna Expressway,  
Greater Noida

**Abstract:-** The relation between anterior corneal astigmatism and total refractive astigmatism is poorly defined in India. The prevalence of astigmatism in especially young patients and those un-co-operative adult patients is a topic of interest and big challenge for an optometrist to correct it properly from avoiding refractive amblyopia in young patients as well as to help them for better vision for comfortable lifestyle. Astigmatism one of the defects of the optical system, has a great effect on the development of visual acuity. Astigmatism is a common optical defect prevails in human eyes. Refractive astigmatism and anterior corneal astigmatism is a different type of astigmatism. Total refractive astigmatism was received by subjective manifest refraction. Anterior corneal astigmatism power different b/w the steep and flat meridians on the anterior corneal surface. Refractive astigmatism is both myopia and hyperopia. Astigmatism are evenly distributed with the axes of higher level of astigmatism close to the horizontal and vertical axes rather than oblique,therefore possibly reducing the risk of astigmatism amblyopia.

**Keyword:-** Total refractive astigmatism,anterior corneal astigmatism internal astigmatism,manual keratometry Retinoscope,Anterior corneal toricity.

## I. INTRODUCTION

Refractive errors are the most common ocular problem causing challenges for public health. As per the recent studies and WHO reports refractive error is the first cause of visual impairment and second cause of visual loss worldwide as 43% of visual impairments are attributed to refractive errors<sup>1</sup>.Astigmatism (from the Greek “a” meaning absence and “stigma” meaning point) is a

refractive error that occurs when parallel rays of light from two principal meridians do not meet at a same point<sup>2</sup>. It is associated with reduced risk of visual acuity<sup>3</sup> and an increased risk of developing refractive amblyopia<sup>4</sup>. Refractive amblyopia is most common of lazy eye.it occurs most commonly when a child is born with high refractive error,one eye may have significant astigmatism other eye does not. Astigmatism 1.0 D reduces visual acuity interferes with visual development and causes various symptoms,such as glare,asthenopia etc. Theories of development of astigmatism based on genetic extraocular muscle tension,visual feedback and eyelid pressure.Refractive and corneal astigmatism are relatively stable between the ages of 6 to 7 years and 12 to 13 years.

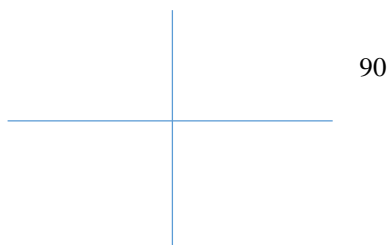
## II. OPTICS OF ASTIGMATIC EYE

In an astigmatic eye the two parallel rays of light from two principal meridians are not focused at a single point. Therefore, ray of light along one meridian converge to form single line of image while ray of light from other meridian are still converging to form a second line of point of image at a distance from the 1<sup>st</sup> line, separated from it by a distance called as focal interval.

The intermediate area between the two focal lines is called as the “conoid of sturm”<sup>5</sup>.

Broadly, it’s of two types:

- Regular astigmatism: Is when the two principle of the eye i.e.M1 and M2 (M1 represent principle meridian having higher value and M2 represent the principle meridian having lower value) are right angle to each other.



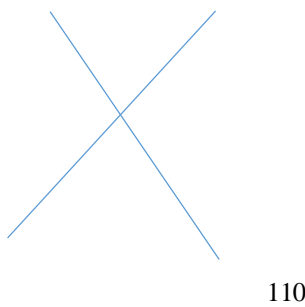
➤ Aetiology:

- Corneal astigmatism: - It contributes higher amount of astigmatism in total refractive astigmatism as it is usually congenital and if acquired will then be causing irregular type of astigmatism<sup>6</sup>.
- Lenticular astigmatism: - It is second most cause to contribute in total refractive astigmatism. As it is relatively constant, which may be due to an emmetropization phenomenon i.e. curvature of lens. But in older ages, lenticular astigmatism is manifested as against- the-rule astigmatism when the corneal astigmatism is decreased<sup>7</sup>.
- Retinal astigmatism: - It contributes occasionally in the total refractive astigmatism. The lens of the eye or the cornea, which is the front surface of the eye, has an irregular curve. This can change the way light passes or refracts, to your retina, causing blurry, fuzzy or distorted vision.

**III. CLASSIFICATION OF REGULAR ASTIGMATISM**

On the basis of axis and angle between two principal meridians, is classified as below:

- WTR: - The two principal meridians are at right angle to one another but the vertical meridian is steeper than the horizontal meridian. Is more commonly seen in young patients where the upper eyelid pressure causes horizontal meridian to be flatter<sup>8</sup>. It changes as one gets older day by day.
- ATR: - Among the two principal meridians the vertical meridian is steeper. Is more commonly seen in older patients i.e. over 40 years of age which changes from with the rule astigmatism changed into against the rule astigmatism <sup>9</sup>. It is suggested that, with the aging, upper eyelid pressure on the cornea and the tone of orbicularis muscle decreases.
- Oblique Astigmatism: - The two principal are not at horizontal and vertical meridian, though these are at right angles to one another.



**IV. REFRACTIVE TYPE OF REGULAR ASTIGMATISM**

Depending upon the position of light rays focused from the retina, is further classified into three types 1). Simple astigmatism – Parallel ray of light from one meridian get focused either in front of or behind the retina whereas the parallel ray of from another meridian get focused on the retina.

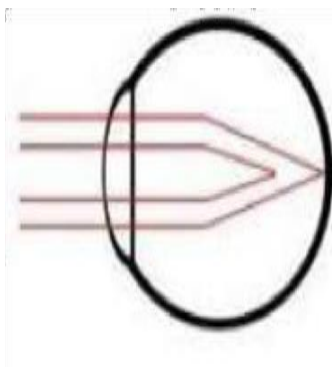


Fig. 4: Simple myopic astigmatism

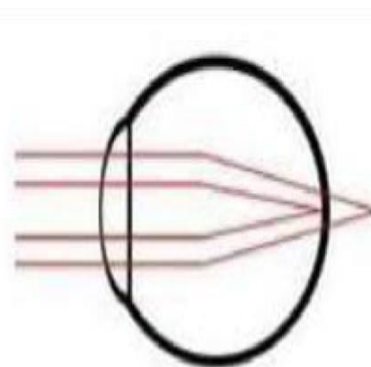


Fig 5: Simple hyperopic astigmatism

- Compound astigmatism – Both parallel ray of light from two principal meridian get focused either in front of or behind the retina.

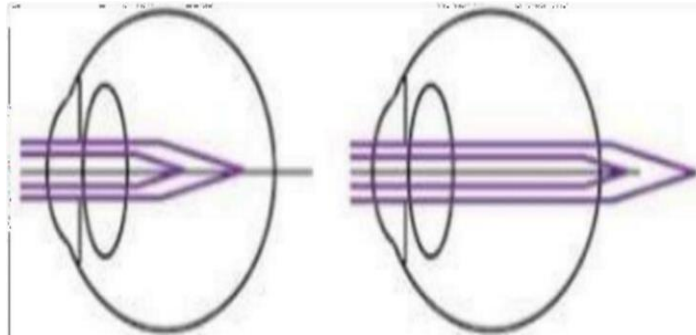


Fig. 6: Compound myopic astigmatism

Fig. 7: Compound hyperopic astigmatism

- Mixed astigmatism – Here parallel ray of light from one principal meridian get focused in front of and another parallel rays of light from second principal meridian get focused behind the retina.

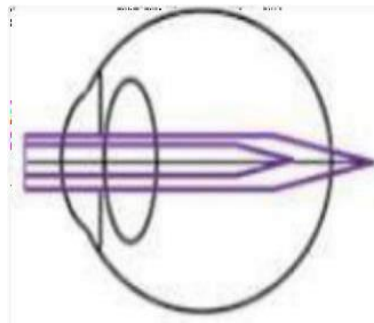
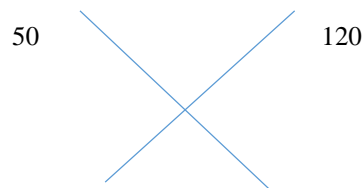


Fig. 8: Mixed astigmatism

- Irregular Astigmatism: - The parallel rays of light from two principal meridians i.e. M1 and M2 are not right angle to each other.



➤ Aetiology: -

- Corneal irregular astigmatism: - This type of astigmatism is caused due to any abnormalities in curvature of cornea like corneal scar, keratoconus etc.
- Lenticular irregular astigmatism: - Is caused to abnormal lens curvature, position and index changes like lenticonus, subluxation, cataractous change etc.
- Retinal irregular astigmatism: - Is seen due to distortion of the macular area due scarring, tumors of retina etc. retinal irregular astigmatism in that the curvature of the eye’s surface is not perfectly round, but there it differs is that instead of the curvature being evenly shaped [mostly in one direction] it is uneven, or curved in multiple directions.

In the review of too many articles, total amount of refractive astigmatism is mostly caused by corneal toricity. Anterior surface of the cornea contribute more in total corneal astigmatism due to significant difference between refractive indices of air and anterior surface of cornea, whereas the difference in refractive indices between posterior corneal surface and the aqueous humor is small which limits the amount of astigmatism caused by toricity

of posterior corneal surface<sup>10</sup>. As the amount of astigmatism contributed by posterior corneal toricity is very minimal so we can neglect it. Therefore, assessment of the total refractive astigmatism only based on the anterior corneal astigmatism can approximately represent the amount of astigmatism and exact determination of axis. Therefore analysis of axis is mainly focused rather than magnitude of astigmatism caused due to anterior corneal surface. Furthermore, amblyopia treatment may be influenced by the orientation of the axis of astigmatism in younger patients and can influence the quality of vision as well as comfort of mainly adult patients.

To the best of our knowledge, similar studies have investigated the possible correlation between total corneal surface astigmatism with the total refractive astigmatism of healthy eyes using direct measurement instruments. Our study aimed to stipulate the contribution of only anterior corneal surface in total refractive astigmatism in an Indian population aged <35 years using keratometer and retinoscope.

## V. DISCUSSION

With the help of modern instrument, measurement of anterior corneal astigmatism and total refractive astigmatism has been more feasible. This study aim to provide baseline information about the contribution of anterior corneal astigmatism in total refractive astigmatism, the prospective cross-sectional study of the patients having astigmatism  $>0.5D$  showed that there is no significant difference between the anterior corneal astigmatism and the total refractive astigmatism. Our study showed orientation of the axis of astigmatism is almost dependent on corneal astigmatism which is similar to Lisa O'Donoghue, 2018. It is also shown that the magnitude of total refractive astigmatism was smaller than the amount of corneal astigmatism was showed in our research which is due to the effect of internal astigmatism.

The technique described here for determining anterior corneal astigmatism (based on Grosvenor and Ratnakaram<sup>16</sup> and Javal<sup>17</sup>) is very simple and effective technique as per the previous studies. Although the method used here measures a small region of the corneal (i.e. 2 points at the 3-4mm over the visual axis) and this measured region is depended on the corneal curvature and its sphericity. As in this study we have considered the patient aged  $<35$  years, we found most of the patients are having with the rule astigmatism as per the previous studies. However our study data also suggest that the axes of refractive astigmatism are evenly distributed, with axes of higher level of astigmatism closer to the horizontal and vertical axes rather than oblique, therefore possibly reducing the risk of astigmatic amblyopia. Although it has been previously reported that hyperopic eyes are more likely to be astigmatic than myopic eyes, and other studies have described an association between refractive astigmatism and myopia our study report that the prevalence of refractive astigmatism increases with both increasing myopia and astigmatism. This association between ametropia and astigmatism indicates that the astigmatic blur in early life may impact on emmetropization of young patients and quality of vision as well as comfort level of adult patients as they are prone to have more asthenopic symptoms if not corrected well. As the refractive error is considered as the first cause of visual impairment, while prevalence of astigmatism in infants been reported as 70% whereas in adult has been documented as 8% to 10%: it is associated with reduced visual acuity and an increased risk of developing refractive amblyopia. Furthermore, amblyopia treatment may be influenced by the orientation of the axis of astigmatism. Through this study we determined the axis and approximate magnitude of astigmatism, depending upon these values astigmatic correction were given to patients especially children and adult who are un co-operative where subjective acceptance is not possible.

## VI. CONCLUSION

There is a high prevalence of both refractive and corneal astigmatism. difference between astigmatism induced by anterior corneal toricity with total refractive astigmatism but when we compared only the axis part of both the anterior corneal astigmatism and total refractive astigmatism which showed that there is no such significant difference between axis orientation of total refractive astigmatism and anterior corneal astigmatism. Hence, we need to look after the internal factors which also plays role in inducing astigmatism. Refractive astigmatism and corneal astigmatism, with the difference between these being due to internal astigmatism, the magnitude of corneal astigmatism is generally greater than that refractive astigmatism.

## REFERENCES

- [1.] Hashemi, H., Fotouhi, A., Yekta, A., Pakzad, R., Ostadimoghaddam, H., & KhaAabazkhoob, M. (2018). International and regional refractive error estimates: A systematic review and meta-analysis. *Current Journal of Ophthalmology*, 30 (1), 3-22.
- [2.] Kaimbo, D. K. W. (2012). Astigmatism - definition, etiology, isolation, diagnosis and treatment not provided. *Astigmatism-Optics, Physiology and Management*.
- [3.] Zhao JPan XSui RMunoz SRSperduto RDEllwein LB Refractive error studies in children: results from Shunyi District, China. *Am J Ophthalmol* 2000; 129 (4) 427- 435
- [4.] Follower, D. S., Rao, S. K., Cheung, E. Y., Islam, M., Chew, S., & Lam, D. S. (2004). Astigmatism in Chinese preschool children: prevalence, flexibility, and impact on refractive development. *British Journal of Ophthalmology*, 88(7), 938-941. <https://doi.org/10.1136/bjo.2003.030338>
- [5.] Sethi HS, S. K. (2018). Comparative analysis of coaxial phacoemulsification with 2.2 and 2.8mm clear corneal incisions . *internal journal of ophthalmology*, 215-222.
- [6.] Kaimbo, D.K. (29, februar, 2012). Astigmatism definition, etiology, classification, diagnosis and non-surgical treatment. shanghai: intech. hofstetter. (2012). *physiology of astigmatism. intechopen*, 1-14.
- [7.] Jane Gwaiazda, M. S. (18 january, 1984). Astigmatism in children: changes in axis and amount from birth to six years. *investigative ophthalmology and visual science*, 88-92.
- [8.] Mohammadi, M. N. (December, 2016). Prevalence of corneal astigmatism before cataract surgery. *International ophthalmology*, 807-817.
- [9.] Feizi S, N. M. (13 march 2017). Distribution of anterior, posterior and total corneal astigmatism in healthy eyes. *Investigation ophthalmology*, 481-491.

- [10.] Ramakrishnan, R. &. (2014). Comparison of manual keratometer with autokeratometer. *Biosci Biotechnol Res Asia*, 339-41.
- [11.] O'Donoghue, L. (2011). Refractive and corneal astigmatism in white school children in northern Ireland. *Investigative ophthalmology and vision science*, 4048-4053.
- [12.] Grosvenor, T. H. (4 April, 1988). Predicting refractive astigmatism: a suggested simplification of Javal's rule. *American journal of optometry and physiological optics*, 292-297.
- [13.] Keller, P. C. (February, 1996). The relation between corneal and total astigmatism. *Optometry and vision science*, 86-91.
- [14.] O'Donoghue, L. (2011). Refractive and corneal astigmatism in white school children in northern Ireland. *Investigative ophthalmology and vision science*, 4048-4053.
- [15.] Shavini Athukorala, N. K. (27 September, 2021). Correlation between keratometric and refractive astigmatism in pseudophakes. *Clin Ophthalmology*, 3909-3913.
- [16.] Feizi S, N. M. (13 March 2017). Distribution of anterior, posterior and total corneal astigmatism in healthy eyes. *Investigation ophthalmology*, 481-491.
- [17.] Auger, P. (November, 1988). Confirmation of the Simplified Javal's Rule. *AM J optom physiol ophthalmology*, 65-915.
- [18.] Sung Uk Han, S. R.-i. (8 March, 2022). Analysis of keratometric measurements in accordance with axial length in an aged population. *Scientific reports*, 02208194.
- [19.] HIRCH, M. (February 1962). Changes in astigmatism during the first eight years of school- an interim report from the Ojai longitudinal study. *Int. ophthalmology*, 51-9.
- [20.] A B Fulton, V. D. (August, 1980). Cycloplegic refractions in infants and young children. *Am J Ophthalmology*, 239-47.
- [21.] Jane Gwaiazda, M. S. (18 January, 1984). Astigmatism in children: changes in axis and amount from birth to six years. *Investigative ophthalmology and vision science*, 88-92.
- [22.] A B Fulton, V. D. (August, 1980). Cycloplegic refractions in infants and young children. *Am J Ophthalmology*, 239-47.
- [23.] Velma Dobson, E. M. (February, 2007). Spherical equivalent refractive error in preschool children from a population with a high prevalence of astigmatism. *Vision science*, 124-30.
- [24.] Mingguang He, J. Z. (March, 2004). Refractive error and visual impairment in urban children in southern China. *Investigation ophthalmology*, 793-9.
- [25.] Tong, L., Saw, S.-M., Lin, Y., Chia, K.-S., Koh, D., & Tan, D. (November, 2004). Incidence and progression of astigmatism in Singaporean children. *Investigative ophthalmology and vision science*, 3914-3918