

Editorial Review:

Astigmatism: Modern views - Review

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Abstract

As for astigmatism in cataract surgery, incision size (width and length) and configuration (1-, 2-, 3-step), incision location relative to the limbus and axis on which the main incision is performed are parameters which has impact on astigmatism and these can help to change preoperative astigmatism. A small incision temporally positioned is thought by most surgeons to be “astigmatically neutral” as compared to a superotemporal, superonasal or superior incision. Woo SJ et al evaluated the effect of central corneal thickness (CCT) on surgically induced astigmatism (SIA) in cataract surgery using temporal clear corneal incisions and concluded that central corneal thickness was negatively correlated with the amount of SIA postoperatively, when the preoperative astigmatism was against the rule (ATR). A thin cornea is more vulnerable to a bending force and causes more deformation (or SIA) in the central cornea.

Keywords : Astigmatism , IOL , glaucoma

Astigmatism - Introduction:

Astigmatism (from the Greek “a” meaning absence and “stigma” meaning point) is a refractive error (ametropia) that occurs when parallel rays of light entering the non-accommodating eye are not focused on the retina [American Academy of Ophthalmology (AAO), 2007].¹ Astigmatism occurs when incident light rays do not converge at a single focal point. The cornea of the normal eye has a uniform curvature, with resulting equal refracting power over its entire surface. Most astigmatic corneas are normal. In some individuals, however, the cornea is not uniform and the curvature is greater in one meridian (plane) than another, much like a football or rugby ball. Light rays refracted by this cornea are not brought to a single point focus, and retinal images from objects both distant and near are blurred and may appear broadened or elongated. This refractive error is called astigmatism [AAO, 2007].¹

Types of astigmatism

Astigmatism is usually described as regular and as irregular astigmatism.²

Regular astigmatism: Regular astigmatism is the type or refractive error correctable by a cylinder lens. A perfect spherocylindrical apparatus is composed solely of spheres and cylinders. A positive sphere is a lens that converges parallel light rays to a single spot. The amount of convergence of the light is inversely proportional to the distance from the source. If the distance is expressed in meters, the vergence is in units of dioptres.²

Irregular astigmatism: In the traditional representation of refractive errors, any refractive error not corrected by a sphere or a cylinder is an irregular astigmatism. While regular astigmatism, or a spherocylindrical refractive error, is a theoretical approximation, irregular astigmatism is what happens in real life. Any irregularity in the surfaces of the

cornea and the crystalline lens and any local change in the refractive index of the lens or the cornea changes the optical power of the system in that location in a way that a spherocylindrical lens cannot fully correct.²

Classes of astigmatism

Non-astigmatic eyes:

- The emmetropic eye (normal): parallel rays of light focus sharply on the retina;
- The myopic eye: parallel rays of light are brought to a focus in front of the retina;
- The hyperopic eye: parallel rays of light would come to a focus behind the retina in the unaccommodated eye.³

Refractive type of Astigmatism:

- Simple myopic astigmatism: one meridian focuses light in front of the retina, the other on the retina;
- Simple hypermetropic astigmatism: one meridian focuses light on the retina, the other behind the retina;
- Compound myopic astigmatism: both meridians focus light in front of the retina;
- Compound hypermetropic astigmatism: both meridians focus light theoretically behind the retina;
- Mixed astigmatism: one meridian focuses light in front of the retina, the other behind the retina.³

Surgical induced astigmatism

As for astigmatism in cataract surgery, incision size (width and length) and configuration (1-, 2-, 3-step), incision location relative to the limbus and axis on which the main incision is performed are parameters which has impact on astigmatism and these can help to change preoperative astigmatism. A small incision temporally positioned is thought by most surgeons to be “astigmatically neutral” as compared to a superotemporal, superonasal or superior incision.⁴ Woo SJ et al evaluated the effect of central corneal thickness (CCT) on surgically induced astigmatism (SIA) in cataract surgery using temporal clear corneal incisions and concluded that central corneal thickness was negatively correlated with the amount of SIA postoperatively, when the preoperative astigmatism was against the rule (ATR). A thin cornea is more vulnerable to a bending force and causes more deformation (or SIA) in the central cornea.⁵

Özyol E et al supported the fact that superior incisions affected more ATR astigmatism than WTR astigmatism.⁶

In a study by Theodoulidou S et al, superolateral/medial incisions affect SIA equally in both WTR and ATR cases. This may be related to the oblique location of the incision. Oblique incisions affect less SIA but lead to greater torque in the axis of astigmatism.⁵

Factors affecting post-operative Astigmatism:

One school of thought has been that it is best to leave the patient with an astigmatic error similar to Pre operative error because the patient is used to a certain spatial image. Other reports claim that preoperative astigmatism can be corrected during cataract surgery by varying the suture material, depth and location of the incision.

A study was conducted by Nielsen PJ to investigate the refractive effects of self-sealing clear corneal incisions of 3.5mm size. It was observed that preoperative against-the-rule astigmatism was reduced significantly by temporally placed clear corneal incisions and preoperative with-the-rule astigmatism by superiorly placed clear corneal incisions.⁷ Thus, if the pre-operative astigmatism was considered while selecting incision type and location of the

incision, one can minimize the post-operative keratometric astigmatism.

According to another study conducted by Roman Set al was done to compare surgically induced astigmatism, post operative astigmatism and uncorrected visual acuity after cataract surgery depending on suture less incision of 4mm (superior sclera or temporal corneal). In cases of WTR astigmatism over 0.75 D a superior scleral approach was preferred .In cases of ATR astigmatism the temporal incision should be considered.⁸

References:

1. American Academy of Ophthalmology Basic and Clinical Science Course Subcommittee. Basic and Clinical Science course. Section 3: Clinical Optics, 2007-2008. San Francisco, CA. American Academy of Ophthalmology; 2007:117-118.
2. Varssano D. Etiology and Clinical Presentation of Astigmatism. In Astigmatism-Optics, Physiology and Management 2012. InTech.
3. Kaimbo DK. Astigmatism—definition, etiology, classification, diagnosis and non-surgical treatment. In Astigmatism-Optics, Physiology and Management 2012. InTech.
4. Theodoulidou S, Asproudis I, Athanasiadis A, Kokkinos M, Aspiotis M. Comparison of surgically induced astigmatism among different surgeons performing the same incision. International journal of ophthalmology. 2017;10(6):1004.
5. Woo SJ, Lee JH. Effect of central corneal thickness on surgically induced astigmatism in cataract surgery. Journal of Cataract & Refractive Surgery. 2003 Dec 1;29(12):2401-6.
6. Özyol E, Özyol P. The relation between superior phacoemulsification incision and steep axis on astigmatic outcomes. International ophthalmology. 2012 Dec 1;32(6):565-70.
7. Nielsen PJ. Prospective evaluation of surgically induced astigmatism and astigmatic keratotomy effects of various self-sealing small incisions. Journal of Cataract & Refractive Surgery. 1995 Jan 1;21(1):43-8.
8. Roman S, Givort G, Ullern M: Choice of the site of incision for cataract surgery without suture according to preoperative astigmatism. Jr Fr Ophthalmol .1997 ;20 (9) :673-9.