



Title of the Protocol: Changes in Angle Kappa and Corneal Back Elevation after Laser in Situ Keratomileusis for myopic astigmatism

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**What is already known on this subject? AND
What does this study add?**

Refractive errors are associated with changes in angle kappa and corneal back elevation at the thinnest point in Pentacam.

The purpose of this study is to track:

The effect of anterior corneal astigmatism treatment on angle kappa and corneal back elevation.

1. INTRODUCTION/ REVIEW

Astigmatism has a corneal component and a lenticular component. Corneal astigmatism occurs when there are differences in the radius of curvature of the cornea in different meridians. ([Morlet et al, 2002](#)).

Astigmatism is classified as “with the rule” when the steep meridian on the corneal surface is between 60 and 120 degrees, and as “against the rule” when the steep meridian on the corneal surface is between 0 and 30 degrees or between 150 and 180 degrees. As the dioptric power of the posterior corneal surface is negative, posterior corneal astigmatism is classified as “with the rule” when the steep meridian on the corneal surface is between 0 and 30 degrees or between 150 and 180 degrees, and as “against the rule” when the steep meridian on the corneal surface is between 60 and 120 degrees. ([Koch et al, 2013](#)).

The magnitude of corneal astigmatism has been reported to vary with age. ([Attebo et al, 1999](#)). There is a shift of the steepest corneal meridian from the vertical (with-the-rule) to the horizontal meridian (against-the-rule). ([Mohammadi et al, 2016](#)).

The mean percentage and magnitude of astigmatism in the population aged 15

to 65 years are: ≥ 0.5 diopter (D) in 73.53%, ≥ 1.0 D in 32.78%, ≥ 1.5 D in 13.55%, ≥ 2.0 D in 6.86% and ≥ 3.0 D in 2.47%. (Gabor et al, 2013)

Angle kappa represents the angle between the visual and pupillary axes (Park et al, 2012). The visual axis connects the fovea with the fixation point and passes by the nodal point. The pupillary axis is the line passing through the center of the pupil perpendicular to the cornea. Angle kappa can be classified as positive (nasal) or negative (temporal). A positive angle kappa of 5.0° on average is generally found in the normal human eye. (Yeo et al, 2012).

Angle kappa decreases with age and tends to be larger in emmetropes and hypermetropes than in myopes). (Hashemi et al, 2010). But the relation of astigmatism to angle kappa still needs further studies. (Larysa et al, 2021).

Angle kappa is a crucial parameter in some surgical decisions. In keratorefractive surgery with a large angle kappa, there is a greater chance of decentration of ablation zones, and it may lead to negative visual effects such as high-order aberrations and under-correction. (Harrer et al, 2017)

Angle kappa is a crucial parameter for proper centration of multifocal intraocular lens implantation. (Prakash et al, 2011)

Higher angle kappa values have been recorded in exotropic patients when compared to esotropic patients. Ophthalmologists must take the kappa angle into account when performing a Hirschberg or Krimsky test in young and uncooperative patients in order to improve surgical results. (Niamh Stone et al, 2009)

The exact angle kappa is classically measured using a synoptophore. (Park, et al.2012). Newer instruments measuring angle kappa are applied in clinical practice such as Orbscan, OPD scan, and Pentacam. (Garzon et al, 2020)

The Pentacam system is a rotating Scheimpflug-based instrument that obtains a three-dimensional model of the anterior segment of the eye which indicates an

image from the anterior corneal surface to the posterior lens surface. The device captures up to 25 slit images of the anterior segment of the eye by a 360-degree rotating Scheimpflug camera, collecting 25, 000 true elevation data points (respecting 500 true elevation points per slit image) within 2 seconds. (Chen and Lam, 2009).

Elevation-based corneal imaging techniques provide valuable information about the posterior corneal surface elevation properties which important in the preoperative examination of refractive surgery, average elevation values For normal eyes, at the posterior apex and thinnest points were $0.8 \pm 3.0 \mu\text{m}$ (SD) and $3.6 \pm 4.7 \mu\text{m}$, respectively. (Koch et al, 2012).

Pentacam measures angle kappa by measuring the distance between the pupil center and the first Purkinje image. (Garzon et al, 2020)

2. AIM/ OBJECTIVES :

The exact relation between anterior corneal astigmatism and angle kappa is still not scientifically understood.

The objectives of this study are to study:

The effect of treating astigmatism on angle kappa and corneal back elevation.

3. METHODOLOGY:

- **Type of Study:** prospective observational study
- **Study Setting:** Ain Shams University and Watany Eye Hospital, Cairo, Egypt.
- **Study Period:** through study completion, an average of 2 years
- **Study Population**

- Inclusion Criteria:

- Subjects aged 21 – 45 years from both sexes.

- myopia up to -8 D
- Corneal astigmatism up to -5 D.
- Stable refraction for 1 year before surgery.
- No ectasia.
- Corneal thickness of more than 500 μm .
- Calculated residual stromal bed of more than 300 μm .
- Axial length up to 30 mm.

- Exclusion Criteria:

None of the patients enrolled have:

- History of previous ocular surgery.
 - History of previous ocular trauma.
 - Corneal opacities within the central 7 mm.
 - Moderate to severe dry eye diseases.
 - Active or previous diseases linked to the anterior segment of the eye.
 - Active or previous diseases linked to the posterior segment of the eye.
 - Diabetic patients.
 - Patients with collagen vascular diseases.
 - Patients with glaucoma.
 - Patients with post-operative complications
- **Sample Size** (100 eyes) will be divided equally into 2 groups:
 - Group 1: subjects have anterior corneal astigmatism of -1.5 to -5 D.
 - Group 2: subjects have anterior corneal astigmatism below -1.5 D.

- **Ethical Considerations**

The study will be conducted in accordance with the ethical standards stated by the ethical committee in the Faculty of Medicine- Ain Shams University,

with informed consent.

• **Study Procedures**

All patients will be scanned by OCULUS Pentacam® HR, Germany and all of them will be subjected to topography-guided femto-Lasik using the FS200 (Alcon Wavelight, Erlangen, Germany) and EX500 devices (Alcon Wavelight, Erlangen, Germany). And all of them will be done by one surgeon.

• **Study Interventions**

All of them will undergo a complete ophthalmic examination to include or exclude cases, examinations including uncorrected distance visual acuity (UDVA) and corrected distance visual acuity (CDVA), IOP measurement, slit lamp examination, fundus examination, and Pentacam tomography.

At least 5 Pentacam scans will be taken for every patient each time. All Pentacam images will be collected and analyzed to measure the horizontal angle kappa, anterior astigmatism and its axis, back elevation data at the thinnest point, Anterior chamber depth and Axial length.

• **Statistical Analysis**

The results will be analyzed and discussed using Microsoft Excel and SPSS.

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