Presentation Title

Investigating the Correlation between Scleral Spur Angle and IOL Tilt

Authors

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Financial Disclosures

Dr. Wang is a consultant for Carl Zeiss Meditec, AcuFocus, Cassini Technologies, and Alcon Laboratories. Dr. Koch is a consultant for Alcon Laboratories, Bausch & Lomb, Carl Zeiss Meditec, and Johnson & Johnson Vision. Dr. Weikert is a consultant for Alcon Laboratories and Carl Zeiss Meditec. The remaining authors have no financial interests in the material presented herein.

Purpose:

- Previously, toric intraocular lens (IOL) tilt was found to modulate induced astigmatism.[1]
- In fact, over-correction or under-correction of astigmatism are both possible according to the orientation of tilt.[1]
- Previous reports suggest that the horizontal, rather than the vertical, contribution to overall IOL tilt is most significant.[2]
- Induced astigmatism may be particularly pronounced in shorter eyes owing to increased tilt magnitude and IOL power.[2,3]
- Given that significant postoperative tilt may affect the selection of IOL toricity, an easy-to-assess proxy for postoperative IOL tilt is warranted pre-operatively.
- While crystalline lens tilt can be used to gauge expected postoperative tilt, this parameter is difficult to obtain with most modern biometers.[3,4]
- The Vertex-Scleral spur angle (SSA), measured by the Anterion SS-OCT (Heidelberg Engineering), can be easily assessed during preoperative scans.
- Thus, the purpose of this study was to evaluate correlation between preoperative SSA and postoperative horizontal IOL tilt.

1. Weikert MP, Golla A, Wang L. Astigmatism induced by intraocular lens tilt evaluated via ray tracing. *J Cataract Refract Surg*. 2018;44(6):745-749. doi:10.1016/J.JCRS.2018.04.035
2. Hirnschall N, Buehren T, Bajramovic F, Trost M, Teuber T, Findl O. Prediction of postoperative intraocular lens tilt using swept-source optical coherence tomography. *J Cataract Refract Surg*. 2017;43(6):732-736. doi:10.1016/J.JCRS.2017.01.026
3. Wang L, Guimaraes de Souza R, Weikert MP, Koch DD. Evaluation of crystalline lens and intraocular lens tilt using a swept-source optical coherence tomography biometer. *J Cataract Refract Surg*. 2019;45(1):35-40. doi:10.1016/j.jcrs.2018.08.025
4. Lu Q, He W, Qian D, Lu Y, Zhu X. Measurement of crystalline lens tilt in high myopic eyes before cataract surgery using swept-source optical coherence tomography. *Eye and Vision*. 2020;7(1). doi:10.1186/S40662-020-00176-5

Methods: Patients & Statistical Analysis

Patients

This study prospectively enrolled subjects who underwent uncomplicated phacoemulsification and IOL implantation.

Inclusion criteria included the following:

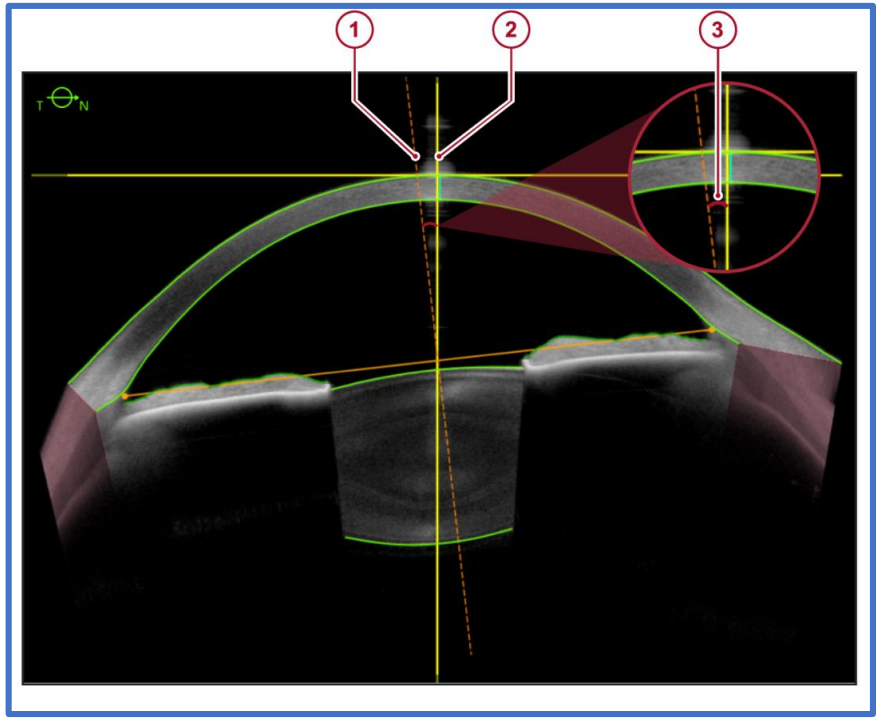
1) Available pre-operative SSA data (Anterion SS-OCT; Heidelberg Engineering).
2) Available postoperative IOL tilt data (Eyestar 900 SS-OCT; Haag-Streit AG) taken at least 3 weeks after cataract surgery.
3) No previous intraocular surgery or intraoperative complications during cataract surgery.
4) No corneal or other ocular pathology affecting visual acuity.

Statistical Analysis

- Statistical analysis utilized Excel (Microsoft Corp., 2024) and RStudio (Rstudio Team, 2024).
- Horizontal IOL tilt was isolated by converting from a polar to cartesian coordinate system.
- Normality of data (spur angle and IOL tilt) was demonstrated with the Shapiro–Wilk test.
- Pearson’s correlation and a linear regression analysis were used determine the correlations between selected variables.

Methods: Measurements

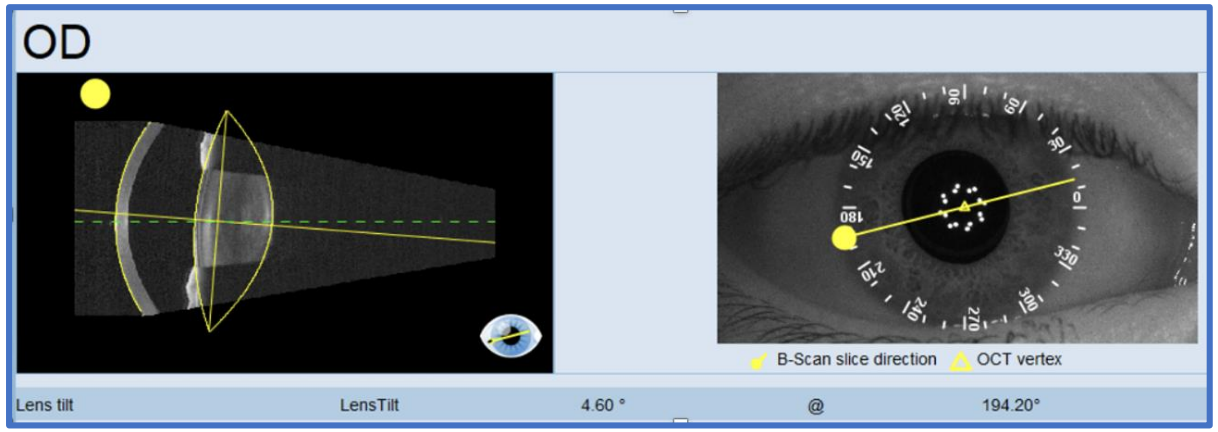
Figure 1. Anterion SS-OCT Display Image



Vertex-Scleral Spur Angle

- Figure 1: Anterion defines the vertex-scleral spur angle (3) as the angle made by the line perpendicular to the scleral spur connection line (2) and the line perpendicular to the anterior corneal surface (1).
- The SSA is displayed as a magnitude (degrees) along the nasal-temporal axis.

Figure 2. Eyestar 900 SS-OCT Display Image



IOL Tilt

- Figure 2: EyeStar 900 defines lens tilt as the maximum tilt of the normal vector of the lens relative to the visual axis of the patient.
- Lens tilt is displayed as a magnitude (degrees) and direction (degrees).

1. ANTERION - Multimodal Imaging Platform Optimized for the Anterior Segment | Heidelberg Engineering. Accessed February 3, 2024. https://business-lounge.heidelbergengineering.com/us/en/products/anterion/

2. Eyestar 900. Accessed February 3, 2024. https://haag-streit.com/en/products/categories/specialty-diagnostics/biometry/eyestar-900

Results:

Table 1. Summary of demographic and biometric data (n = 32 eyes).

Characteristic	**Data** (mean ± SD, min-max)
Age (yrs)	70 ± 8, 55-87
Gender: male/female	19/13
Axial length (mm)	24.68 ± 2.02, 20.24-28.77
Scleral spur angle magnitude [a] (°)	5° ± 2°, 1°- 9°
IOL tilt magnitude [b] (°)	5.51° ± 1.27°, 2.62°- 7.83°
Right eye IOL tilt direction [b] (°)	199° ± 19°, 170°- 238°
Left eye IOL tilt direction [b] (°)	341° ± 15°, 305°- 005°

IOL = intraocular lens; SD = standard deviation; [a] Assessed by Anterion SS-OCT; [b] Assessed by Eyestar 900 SS-OCT

Results: Scleral Spur Angle Magnitude (Anterion SS-OCT)

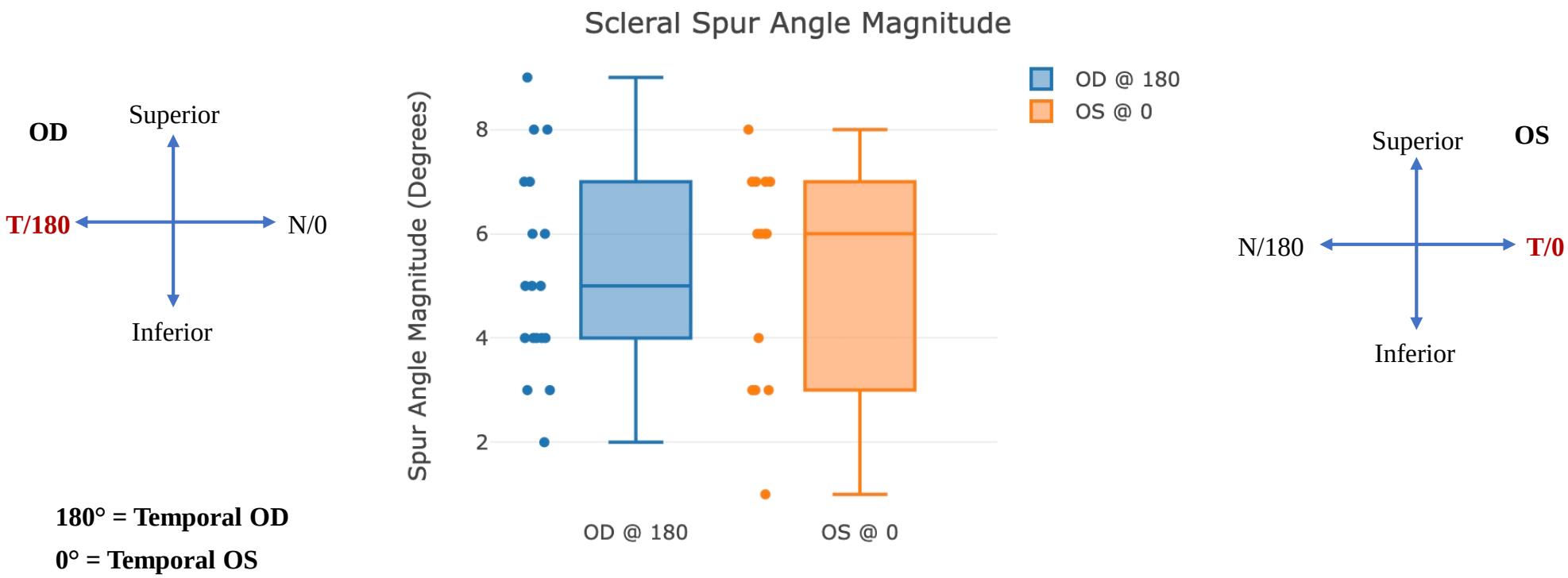


Figure 3. Box-and-whisker plots demonstrating variability of SSA magnitude measured by the Anterion SS-OCT.

Takeaway: Scleral Spur Angles are measured according to the nasal-temporal axis and the SSA magnitude is calculated from a vector that always points temporally. Thus, we can only derive information regarding horizontal, rather than vertical, tilt.

Results: Distribution of IOL Tilt (Eyestar 900 SS-OCT)

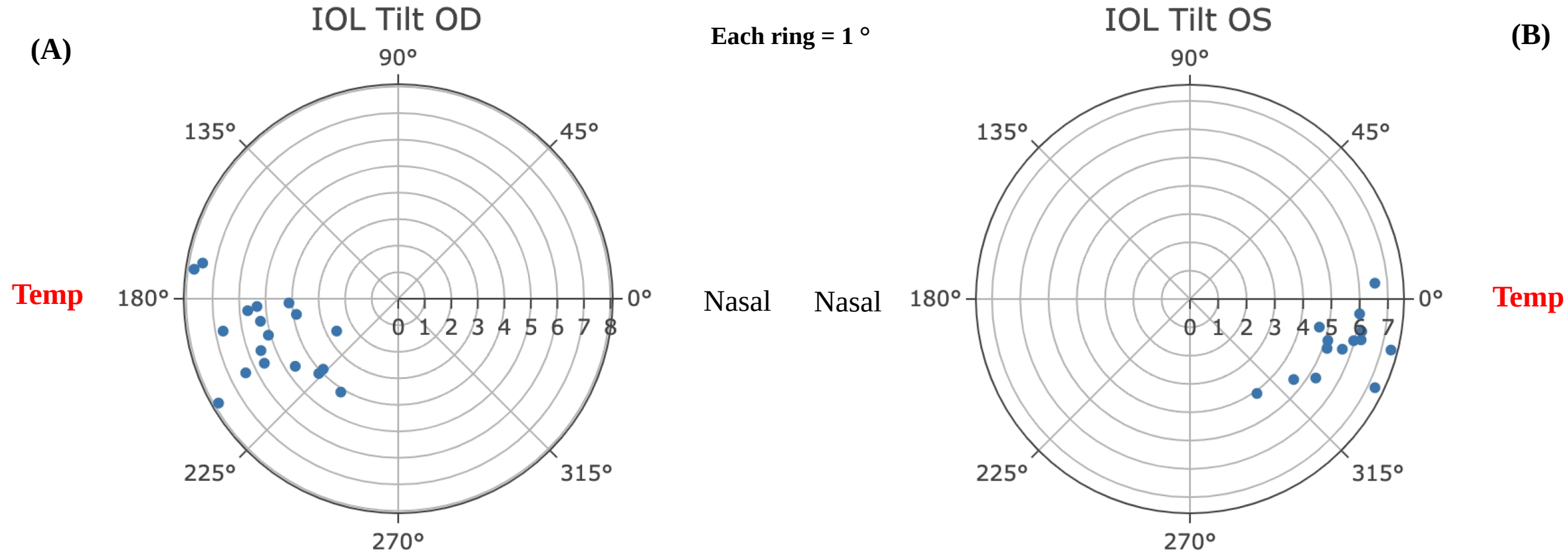


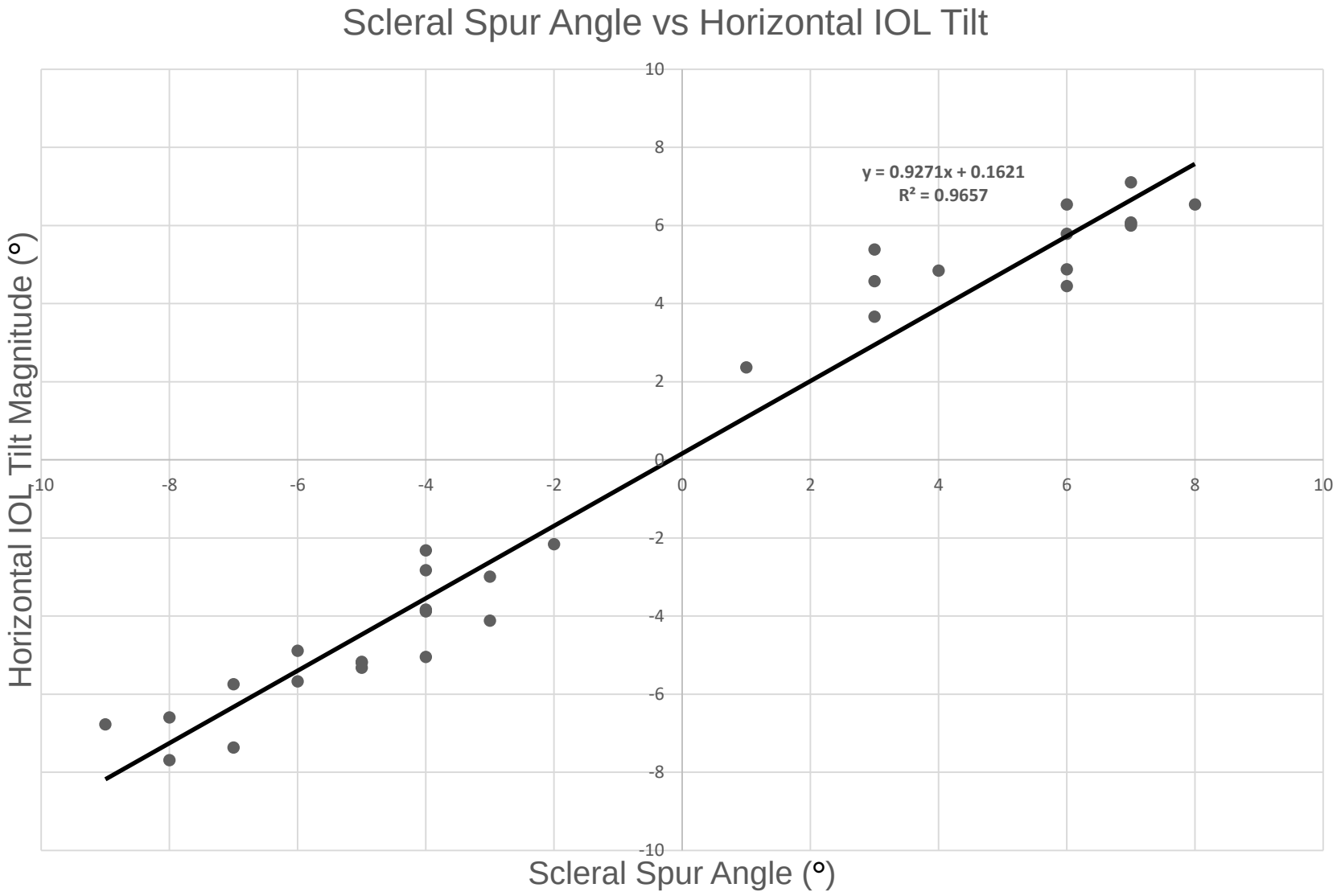
Figure 4. Polar plots demonstrating orientation and magnitude of IOL tilt in the right (a) and left (b) eyes.

Takeaway: Lens tilt orientation demonstrates an inferotemporal tendency in right and left eyes.

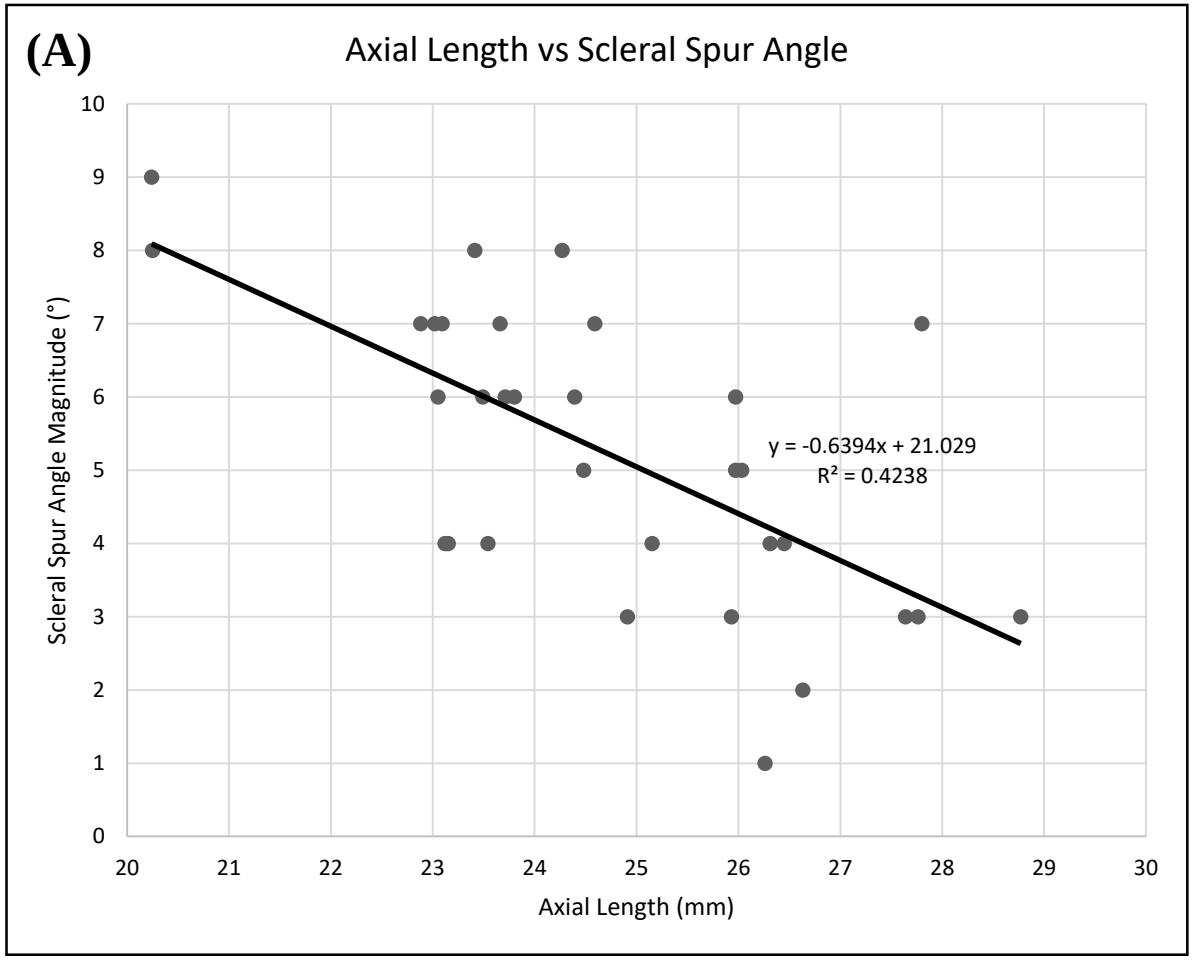
Results: Scleral Spur Angle vs Horizontal IOL Tilt

Figure 5. Correlation of scleral spur angle and horizontal IOL tilt (Correlation coefficient $r = 0.982$, $P < 0.05$).

Takeaway: In 32 eyes, correlation analysis revealed that the scleral spur angle significantly and positively correlated with the magnitude of horizontal IOL tilt.



Results: Correlations with Axial Length



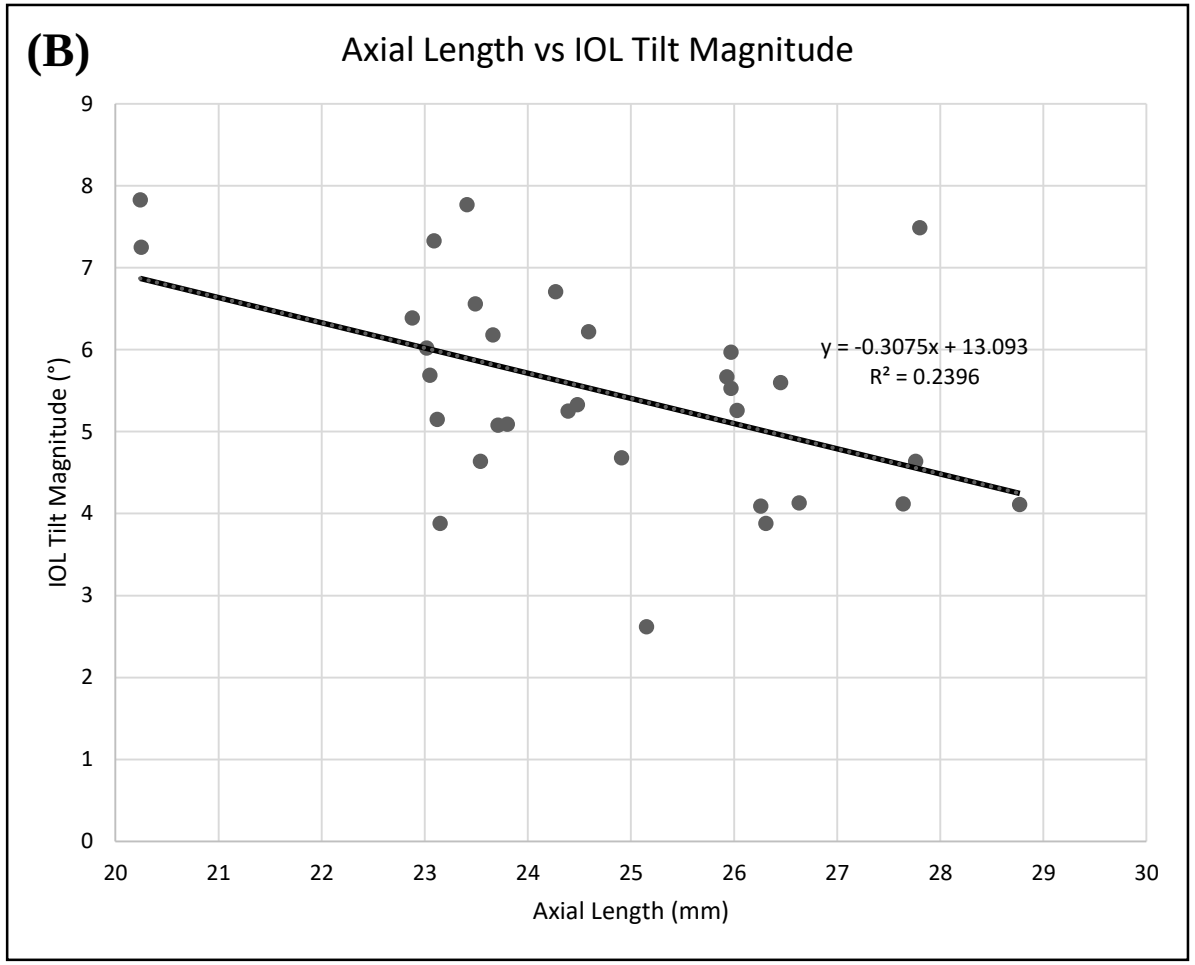


Figure 6. Correlation of the axial length and scleral spur angle (a; correlation coefficient r = -0.651, $P < 0.05$) and correlation of the axial length and IOL tilt magnitude (b; correlation coefficient r = -0.490, $P < 0.05$).

Takeaway: Scleral spur angle and IOL tilt magnitude are negatively correlated with axial length.

Conclusion:

- The vertex-scleral spur angle provides an easy-to-assess approximation for horizontal IOL tilt magnitude pre-operatively.
- The orientation of IOL tilt (inferotemporal predominance) measured on the Eyestar 900 is consistent with prior studies using other biometers.[1-3]
- Both scleral spur angle and overall IOL tilt magnitude were negatively correlated with axial length.
- Larger studies are needed to correlate scleral spur angle, IOL tilt, and toric IOL visual outcomes.

1. Hirnschall N, Buehren T, Bajramovic F, Trost M, Teuber T, Findl O. Prediction of postoperative intraocular lens tilt using swept-source optical coherence tomography. *J Cataract Refract Surg*. 2017;43(6):732-736. doi:10.1016/J.JCRS.2017.01.026
2. Wang L, Guimaraes de Souza R, Weikert MP, Koch DD. Evaluation of crystalline lens and intraocular lens tilt using a swept-source optical coherence tomography biometer. *J Cataract Refract Surg*. 2019;45(1):35-40. doi:10.1016/j.jcrs.2018.08.025
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