A theoretical approach to estimate the impact of the corneo-scleral junction angle on ocular sagittal height

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Introduction

When contact lenses are fitted, the corneo-scleral junction angle (CSJ) is relevant for all lenses that land beyond the cornea. This is the case with soft, hybrid, and scleral lenses.[1] The CSJ angle has some impact on the sagittal height of the anterior eye (OC-SAG), which cannot be predicted based on mere extrapolation from the cornea.[2] Consequently, large contact lenses designed with sagittal values derived from corneal parameters may not provide an optimal fit.[2,3] A regression equation or a former measurement of the corneoscleral geometry is needed to obtain a reliable value of sagittal height.[2,3] Furthermore, when scleral lenses are designed, a transition zone between the optic zone and the landing zone is required to fit the CSJ angle ***(Figure 1)***.[4] In addition to being designed with transition zones (often bicurve, tricurve, or with aspherical designs),[5] some lens flexure is expected in hybrid and soft lenses in the corneoscleral area to fit the CSJ profile ***(Figure 2)***.[6]

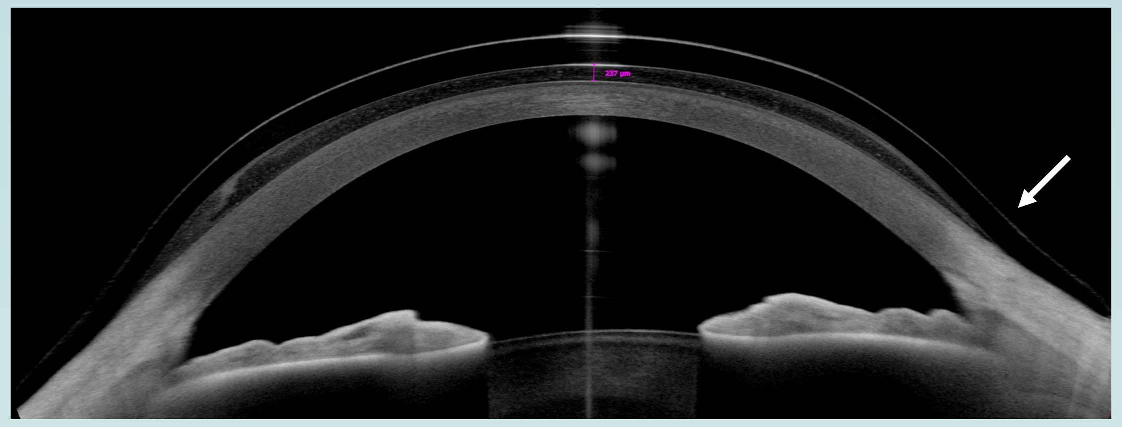

Figure 1: View of a scleral lens with AS-OCT. Note the transition zone of the lens over the CSJ angle (white arrow).

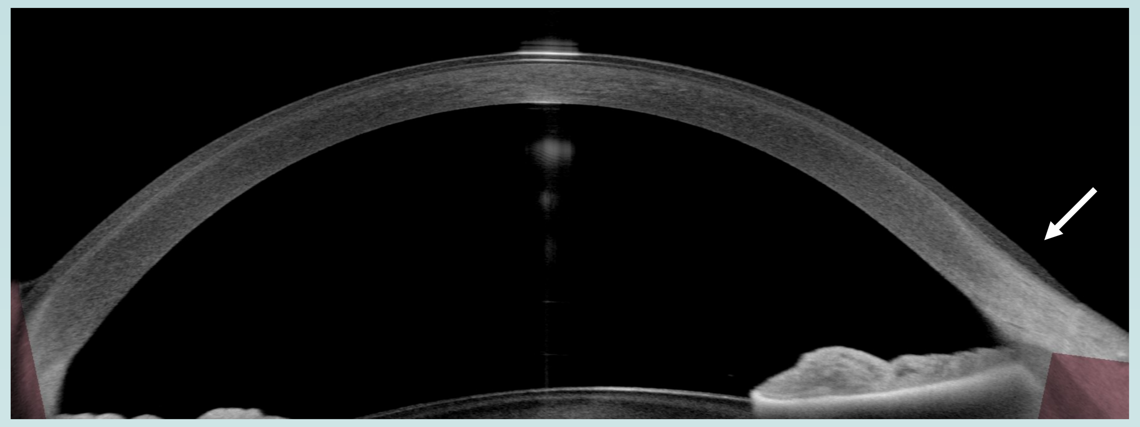

Figure 2: View of a soft lens with AS-OCT. Note how the lens flexes over the CSJ angle (white arrow).

Purpose

The aim of this study was to estimate the impact of small variations in the corneo-scleral junction (CSJ) angle on OC-SAG by means of a theoretical model.

Methods

A theoretical model was created to calculate the tangent angle at the end of an asphere of 12 mm. The asphere is calculated from the keratometry and eccentricity values ***(Equation 1)***. At the end of the asphere, over the last 0.1 mm, an aligning tangent angle is calculated ***(Equation 2)***. This angle is then reduced or increased up to 5 degrees to simulate the CSJ.

The OC-SAG was calculated with this model ***(Figure 3)*** for a smooth and tangential transition from the cornea to the sclera (CJS angle = 0 degrees) and then for variations of 1 degree towards both flatter and steeper angles from -5 to 5 degrees ***(Figure 4)***.

$$S = \frac{r - \sqrt{r^2 - \left(\frac{d}{2}\right)^2}}{p}$$

Equation 1: Asphere calculation.

$$\propto = arctg\,\frac{OCSAG@10\ mm - OCSAG@9.9\ mm}{0.05}$$

Equation 2: tangent angle calculation.

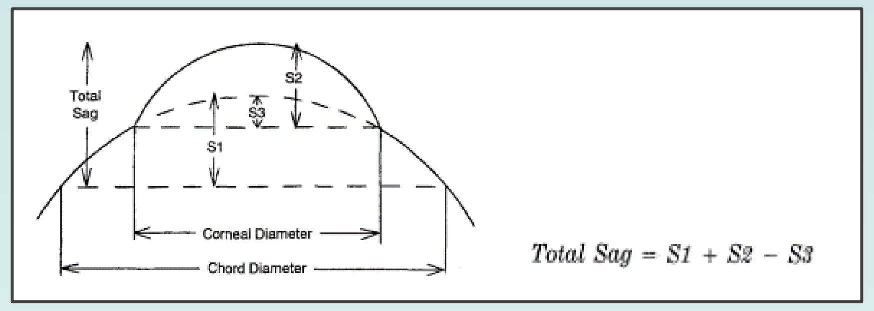

Figure 3: OC-SAG calculation.

Results

For a mean eye with k values 7.80 mm and eccentricity 0.6, the OC-SAG at 15 mm chord was 3512 µm when a tangential transition from the cornea to the sclera (CSJ angle = 0 degrees) was considered. OC-SAG was also calculated for variations of 1 degree between -5 degrees (flatter or less elevated scleras) and 5 degrees (steeper scleras). The mean OC-SAG for CSJ angles of 0±5 degrees was 3587±226 µm and the mean variation for each degree was 68±5 µm.

Slightly larger, increasing differences were observed when moving to steeper CSJ angles (from 0 to 5 degrees) and smaller and decreasing differences were found when flatter angles (from 0 to -5 degrees) were considered ***(Table 1)***.

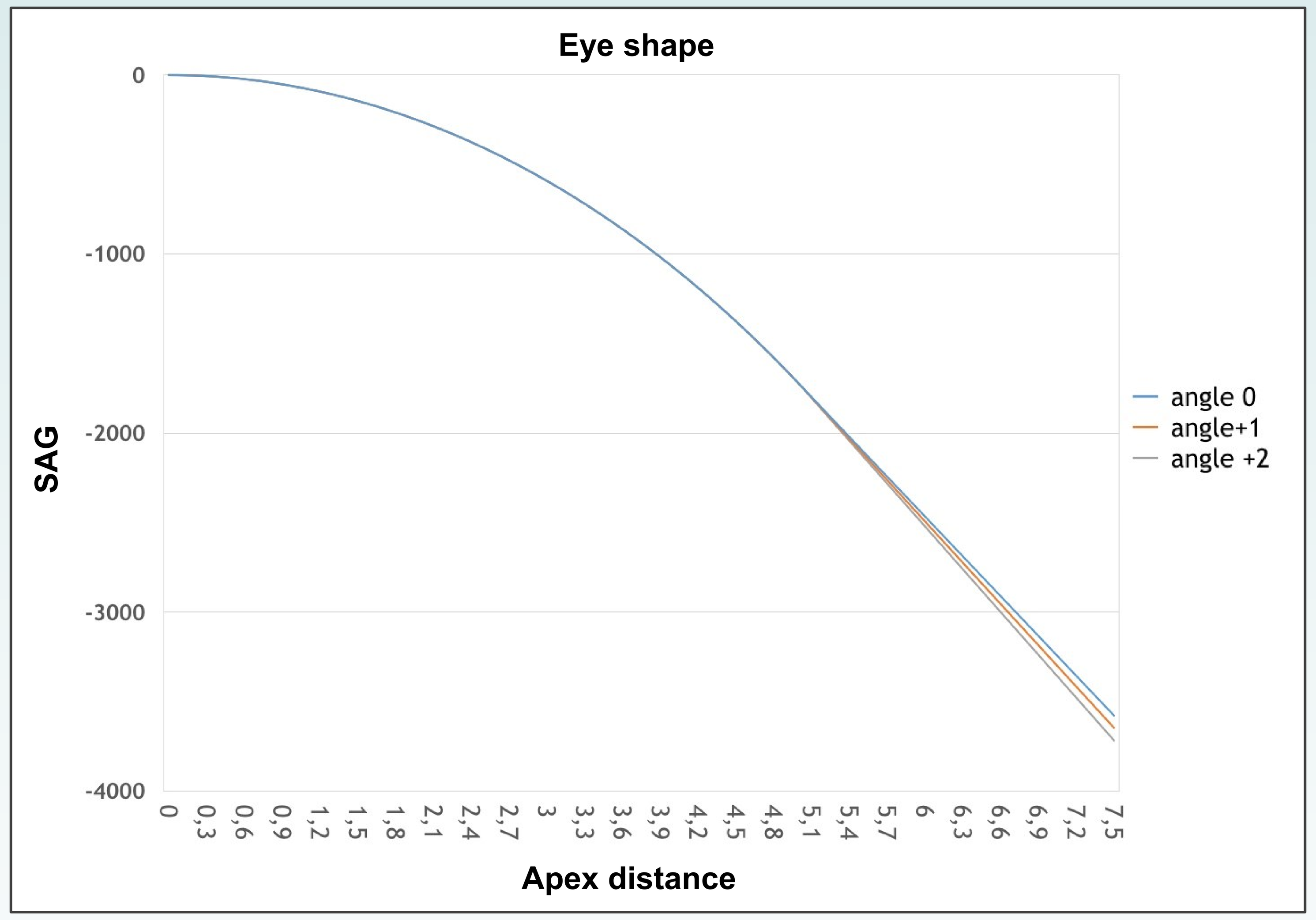

Figure 4: A theoretical model to calculate the OC-SAG for CSJ angle variations of 1 degree.

Angle	OC-SAG (µm)	Difference (µm)
-5º	3260	61
-4º	3321	62
-3º	3383	64
-2º	3444	65
-1º	3512	67
0º	3579	
1º	3647	68
2º	3718	71
3º	3790	72
4º	3864	74
5º	3941	77
Mean	3587	68
SD	226	5

Table 1: Results for OC-SAG calculations for each single degree of CSJ variation.

Discussion and conclusions

Previous studies have found that 77% of eyes have CSJ angles within 5 and 180 degrees and one-fifth are within ±1 degrees.[13] Based on these results, extrapolations have been made to calculate the OC-SAG beyond the cornea, assuming a tangential transition from the cornea to the sclera.[14] This theoretical model establishes differences of 135 and 340 µm for CSJ angle variations of 2 and 5 degrees respectively, when the corneal parameters are kept constant.

In terms of clinical significance, the δ-sag parameter has recently been used to define the difference or relationship between contact lens sagittal height (CL-SAG) and OC-SAG with custom soft contact lenses.[15] While there is limited information about the ideal δ-sag when custom soft lenses are fitted, Michaud et al. [16] reported optimal fit and comfort with +200 µm and Montani suggested +350 µm.[17] Nevertheless, the soft lens fitting is also dependent on many other factors such as the material and design.[18] When scleral lenses are fitted, there is a greater consensus and a tear reservoir (TR) thickness of 300–350 µm is accepted on insertion, as it is assumed that it will settle down to around 200 µm after a few hours.[19] Therefore, if the target is a δ-sag or TR thickness between 200 to 350, CSJ angle variations of 2 and 5 degrees may be significant as they have an impact on OC-SAG of 135 and 340 µm respectively.

A limitation is that the present study isolates the CSJ angle and keeps corneal parameters constant, when the OC-SAG is a parameter in which the corneal radius, eccentricity and diameter are involved.

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Disclosures: Reinier Stortelder, employee of Eaglet Eye and Javier Rojas, consultant for Eaglet Eye.