Corneoscleral junction angle in healthy eyes assessed objectively

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Introduction

Several authors have attempted to measure the CSJ angle using optical coherence tomography (OCT) [1-3]. Seguí-Crespo et al. and Hall et al. measured the angle by means of a point-and-click calliper that an observer manually manipulated to locate the CSJ and measure the angle [1,2]. Tan et al. went a step further and developed an algorithm to automatically measure the angle, although the CSJ was still located manually by an observer [3]. They described good inter-observer repeatability but found some differences in reproducibility between observers [3]. Moreover, measurements of the CSJ angle in these studies were taken at a single point of each quadrant.

Purpose

The aim of this study was to introduce a fully objective, automated methodology to estimate CSJ angle in 360 degrees in the limbal position, assessed from 3-dimensional corneoscleral topography [4,5]. This methodology was used to evaluate the mean CSJ angle in healthy eyes objectively.

Methods

The corneoscleral topography of 105 healthy right eyes of Caucasian subjects (67% women and 33% men) aged between 18 and 59 years were retrospectively analysed. These eyes were previously measured with the Eye Surface Profiler (ESP, Eaglet Eye, The Netherlands). The raw anterior eye height data (x, y, and z coordinates) were exported to build three-dimensional corneoscleral topography maps in a four-step process:

1. The limbus position was calculated in 360 semi-meridians using a purpose-designed algorithm [4,5].
2. After limbus demarcation, auxiliary points were placed 0.6 mm horizontally away from the limbus (yellow squares in Figure 1). Angle α (see Figure 1) was evaluated as the arctangent of the adjacent, i.e., 0.6 mm, and the opposite α, calculated as the distance between the corresponding auxiliary points. The same procedure was repeated to estimate angle β (see Figure 1).
3. In the following step, angle ϕ (see Figure 1) was calculated as $\phi = 180° - \alpha$ (see Figure 1).
4. Finally, the CSJ angle was obtained: $CSJ = \phi + \beta$ (see Figure 1).

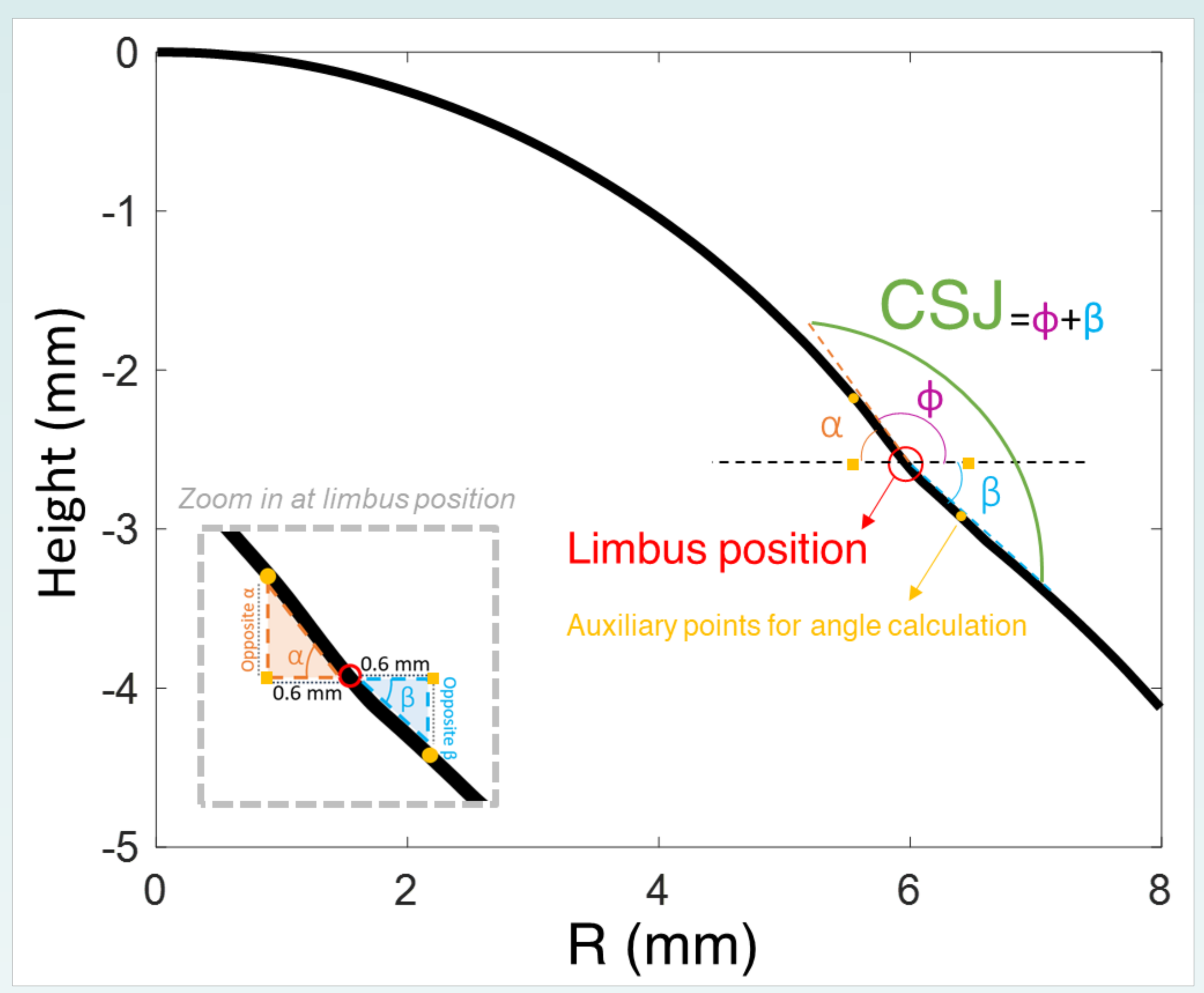

Figure 1. Methodology for corneoscleral junction (CSJ) angle calculation. The solid black line corresponds to the corneoscleral profile in one out of 360 semi-meridians. For details on angle estimation see the text.

Results

- ✓The group's mean CSJ angle was 177.5 ± 1.1°
- ✓Regional differences were observed (Table 1)
- ✓The CSJ angle was rotationally asymmetric (Figure 2). There was a mean 7.7 ± 3.7° difference between the steepest (smallest) and flattest (largest) angle within the same eye (greatly depended on the individual as it ranged from 3.5° to 17.8°).
- ✓The CSJ angle was smaller (steeper) in the nasal region than in the remaining sectors.
- ✓The CSJ angle and limbal radius provided by the ESP were moderately correlated (r=0.43, p<0.001).

Quadrant	Mean CSJ angle ± SD (°)	Range (°)	p-value (paired t-test)
Nasal	176.4 ± 1.1	[172.9, 178.7]	<0.001
Temporal	178.2 ± 1.4	[171.4, 180.6]	
Superior	178.1 ± 1.1	[173.3, 180.6]	0.038
Inferior	177.9 ± 1.1	[173.9, 180.9]	

***Table 1.** Mean CSJ angle per quadrant.*

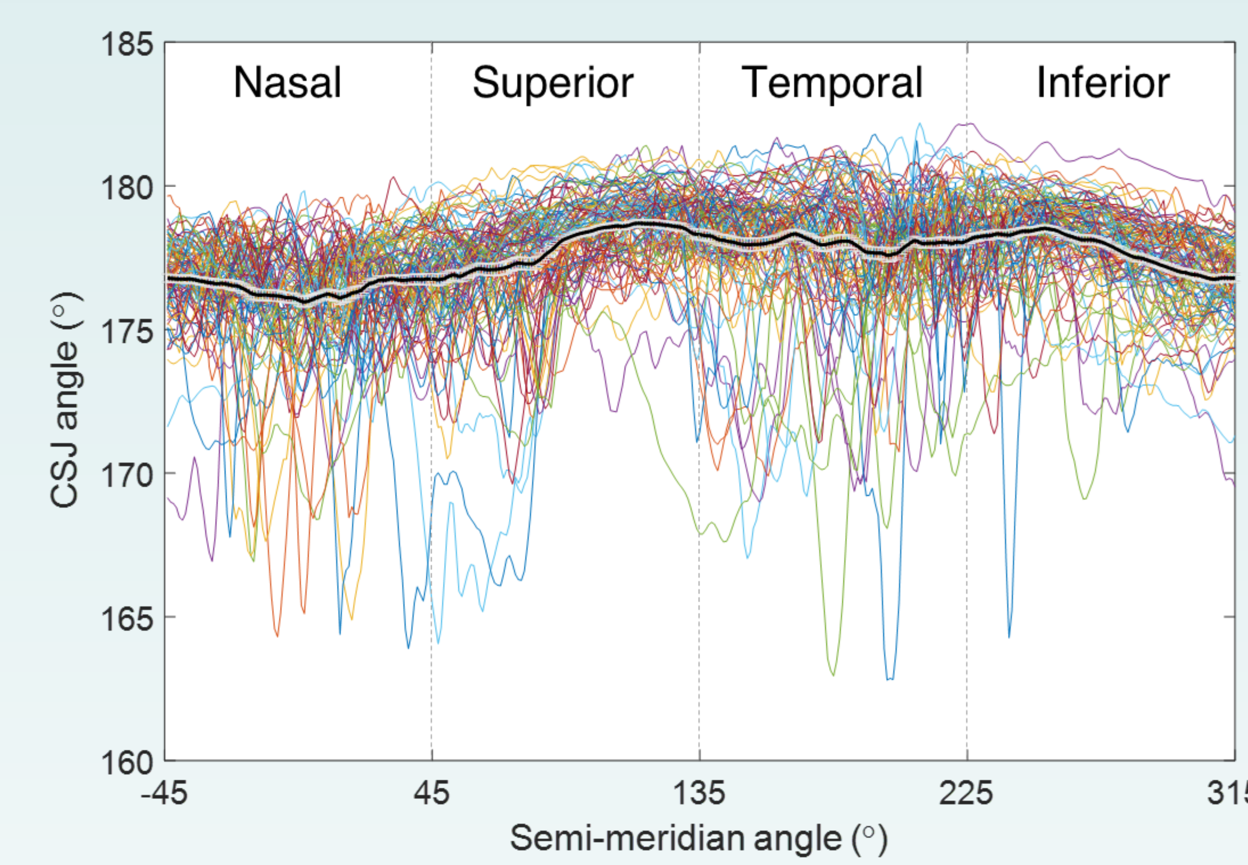

***Figure 2.** Individual CSJ angle in each sector in all 105 eyes (colour lines). Corresponding mean CSJ angle (black line) and error bars (in light gray) indicating ± standard error are also shown.*

Discussion and conclusions

The CSJ angle influences sagittal height, a key parameter for ensuring a successful lens fit, especially in large-diameter lenses. However, to date, only a few works have characterised this parameter [2,6]. These are based on manually positioning virtual callipers on an image, which makes the process subjective and poorly repeatable [7]. This novel method is designed to obtain a more complete, realistic description of the transition from the cornea to the sclera than the current standards, and to avoid the loss of accuracy inherent in subjective criteria [8]

References

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Credentials

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