Considerations when comparing scleral shape differences

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Background

Corneal difference maps are a popular method to track and trace the development of corneal diseases as well as the condition of the cornea post-operative. Following the same approach for scleral profilometry sounds logical. In this poster a couple of considerations are discussed when comparing sagittal height (SAG) maps.

Method

Profilometry measures fluorescein sodium dissolved in the tear layer. Thus profilometry measures the tear layer on top of the conjunctiva which is on top of the sclera. The diurnal variation of the cornea is reported to be about 30 microns. The changes for the sclera are reported as 9 microns but the conjunctiva may show a difference up to almost 60 microns. No studies have been looking into the total effect on the SAG. Adding these numbers together could mean that SAG may differ up to 100 microns during the day. The influence of wetting drops or drugs post-operatively have not been studied but could potentially alter the SAG significantly.

The position of the apex could be defined as the highest point of the eye. Often a corneal operation changes the central part of the cornea. This will relocate the apex. When comparing two SAG maps the apex is always the reference point, placed at 0,0,0 when looking at the three-dimensional space (X,Y,Z). The post-operative apex may show a shift in any of the 3 directions.

Comparing SAG maps does require rotation of the data as well. Rotation of X,Y,Z could be explained as levelling the eye to a horizontal plane.

Results

Three figures are presented to illustrate the misleading effect of difference maps after corneal changes . Aligning the apices and levelling of the X,Y,Z data is based on the location of the limbus. The SAG difference at the apex location will always be 0 microns. Whereas in reality this is more or less the location with the largest changes.

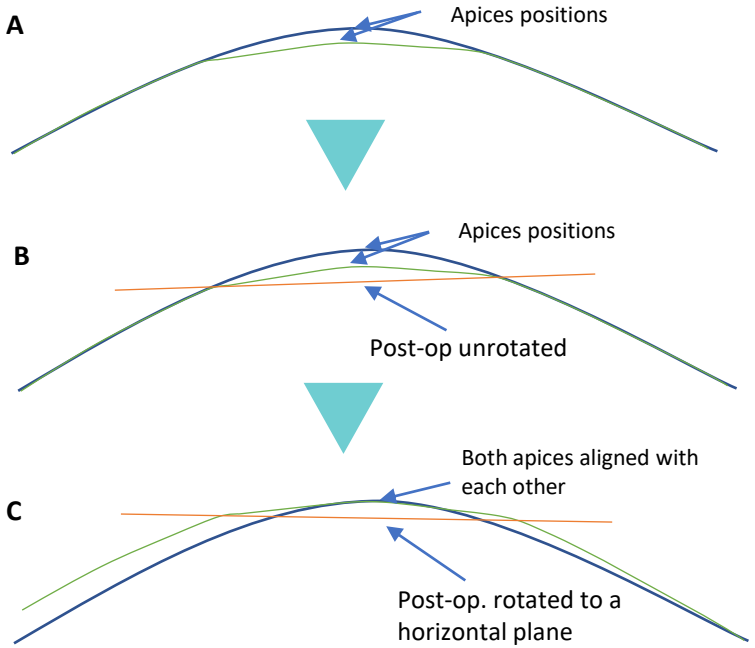

Figure 1: 2D visualization what happens with the eye pre- and post-operative (or with orthokeratology). The position of the apex shifts, which directly influences the SAG as well as the rotation. Although the scleral shape is the same (in green) it does not align with the pre-op position of the sclera(image C).

Conclusion

Comparing SAG maps pre- and post-operative may lead to inadequate conclusions. Therefore, examples are presented in this poster to show possible drawbacks. Future research could focus on fitting the data based on the limbus. So far it remains unknown if the limbus is influenced after corneal operations.

All publications concerning SAG difference maps should describe how the data is fitted and rotated.

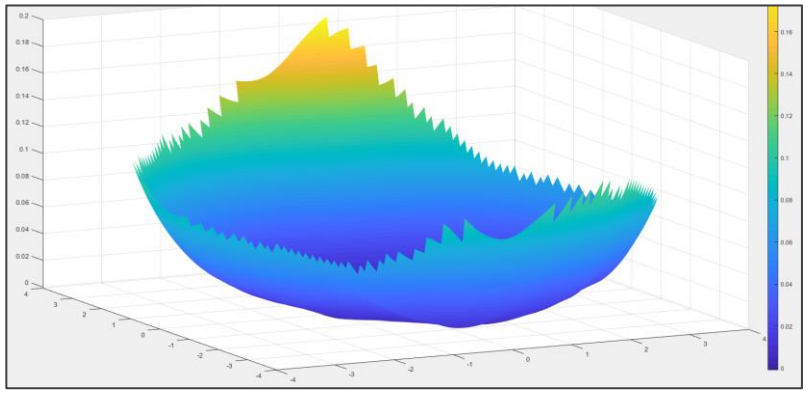

Figure 2: Corneal difference map of an eye pre- and post-LASIK. Both measurements have been rotated such that the limbus is in the horizontal plane. The map suggests that the largest difference is peripheral. This may give a false impression of the actual shape changes.

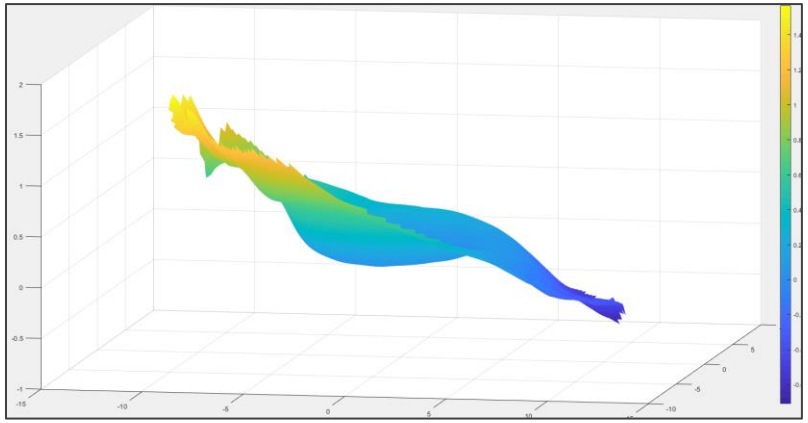

Figure 3: Corneo-scleral difference map of an eye pre- and post-LASIK.
Due to the shift of the apex in an unknown direction aligning the maps with each other is impossible if the apex is used as the reference point. This image shows an extreme tilt due to shift of the apex post-operative.