Response of the anterior sclera to accommodation in myopes and emmetropes

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PURPOSE

- **The biomechanical properties of the sclera are documented to be altered in eyes with myopia, with the myopic sclera thought to be more susceptible to deformation from otherwise normal ocular forces.[1]**
- **The close anatomical and functional relationship between the ciliary body and sclera suggests that ciliary muscle contraction during accommodation may influence the overlying sclera.**
- **This study aimed to characterise the changes occurring in anterior scleral thickness with accommodation using anterior segment optical coherence tomography (AS-OCT) in young adult myopes and emmetropes.**

METHODS

- **The thickness of the temporal anterior sclera was measured in 20 myopes and 20 emmetropes (mean age 21 ± 2 yrs) during 0, 3 and 6 D accommodation demands with the Spectralis AS-OCT (Figure 1).**

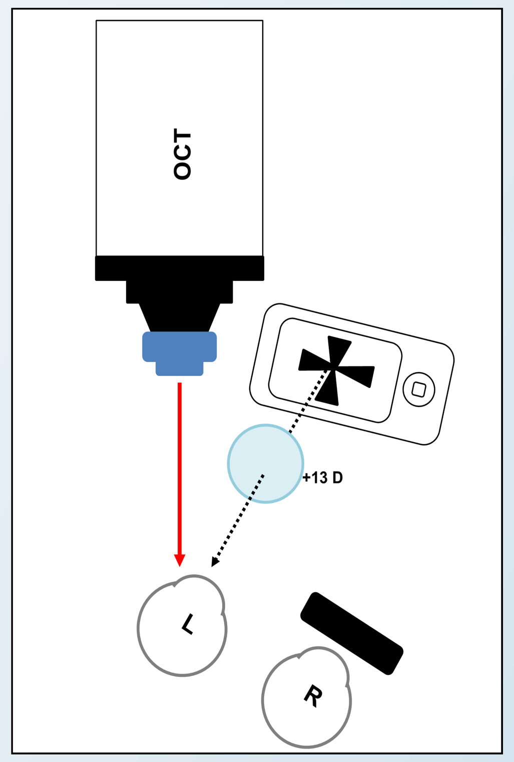

Figure 1. Schematic of experimental set up. Aerial view of 13 D Badal optometer mounted in front of the AS-OCT objective lens, to correct the participants' ametropia and provide 0, 3 and 6 D accommodation demands. The Badal system target was a Maltese cross displayed on an LCD screen. The right eye was occluded for the duration of the experiment.

- **A high resolution (axial resolution 3.9 µm, transverse resolution 11 µm) volume scan and associated en-face image was captured at each accommodation level (Figure 2).**
- **Each volume scan was rotated and translocated (based on identification of common anatomical landmarks in the corresponding en-face image) to register the measurements to the same location.**

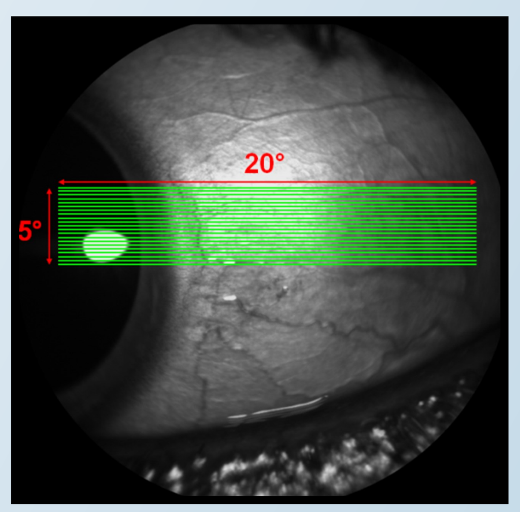

Figure 2. En-face image showing the high resolution scanning protocol performed on the left temporal sclera. Each scan consisted of 21 lines of 30 averaged B-scans at each accommodation level.

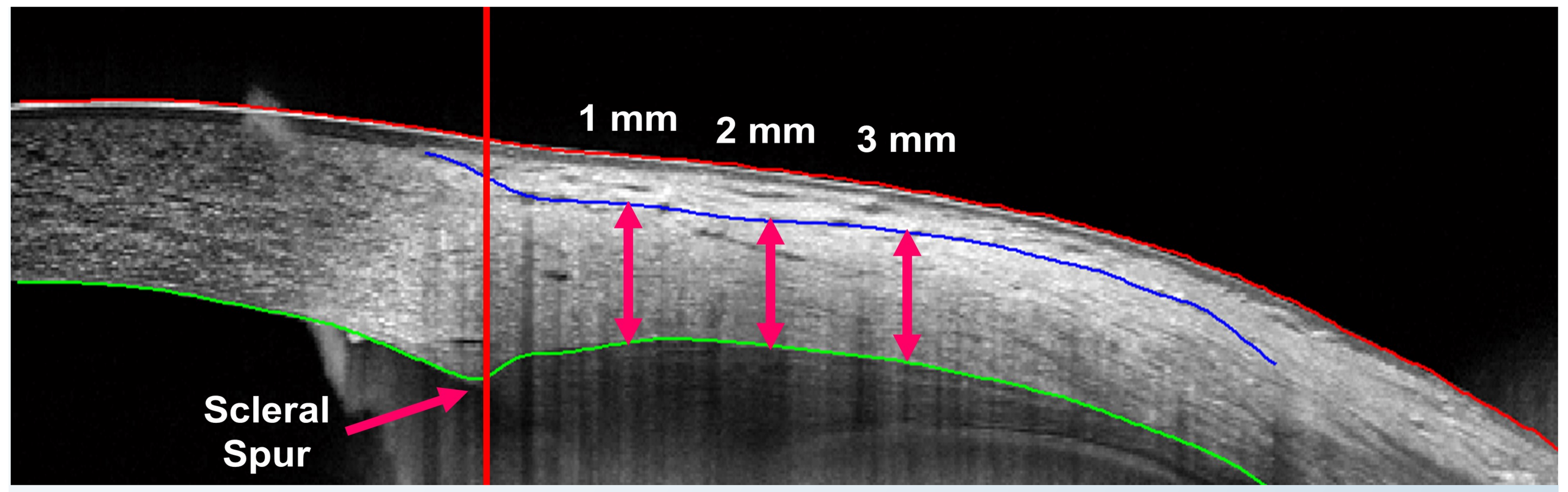

Figure 3. A typical B-scan of the anterior temporal sclera with segmentation of the anterior conjunctiva (red), anterior sclera (blue) and posterior sclera (green). The vertical red line marks the position of the scleral spur, and the location of the discrete points 1, 2 and 3 mm posterior to the scleral spur are shown by the arrows.

- **The corresponding line scan of each rotated volume scan were identified, and the anterior conjunctival, anterior scleral and posterior scleral boundaries were segmented using a semi-automated procedure to allow calculation of anterior scleral thickness at each accommodation level at discrete points 1, 2 and 3 mm posterior to the scleral spur (Figure 3).**

RESULTS

- **The scleral thickness at baseline (0 D) varied significantly with distance from the scleral spur (mean thickness 512 ± 52 µm at 1 mm, 504 ± 60 µm at 2 mm and 543 ± 67 µm at 3 mm from the scleral spur, $p < 0.001$), but was not significantly different between myopes and emmetropes ($p > 0.05$).**
- **Anterior scleral thickness did change significantly with accommodation, with significant thinning occurring at 6 D (−8 ± 21 µm, $p < 0.05$), and thinning which approached significance at 3 D (−6 ± 20 µm, $p = 0.07$) (Figure 4).**

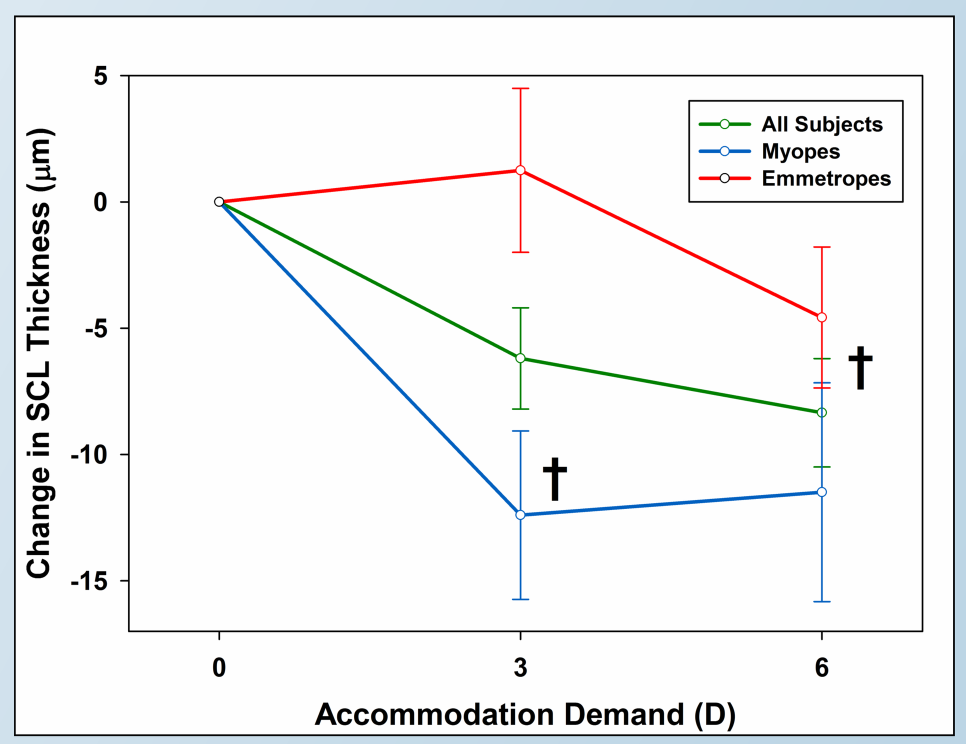

Figure 4. Change in average scleral thickness (mean ± SEM, µm) from baseline in the myopic and emmetropic participants to the 3 and 6 D stimulus. Cross (†) indicates a significant change from baseline ($p < 0.05$).

- **The scleral changes with accommodation were different between the refractive groups.**
- **While all subjects' sclerae thinned significantly at the 1 mm location with 3 D, significant ($p < 0.001$) refractive group differences occurred at 3 mm from the scleral spur, with myopes thinning significantly with both 3 D (−12 ± 21 µm) and 6 D (−19 ± 17 µm), and the emmetropes showing no significant change (Figure 5).**

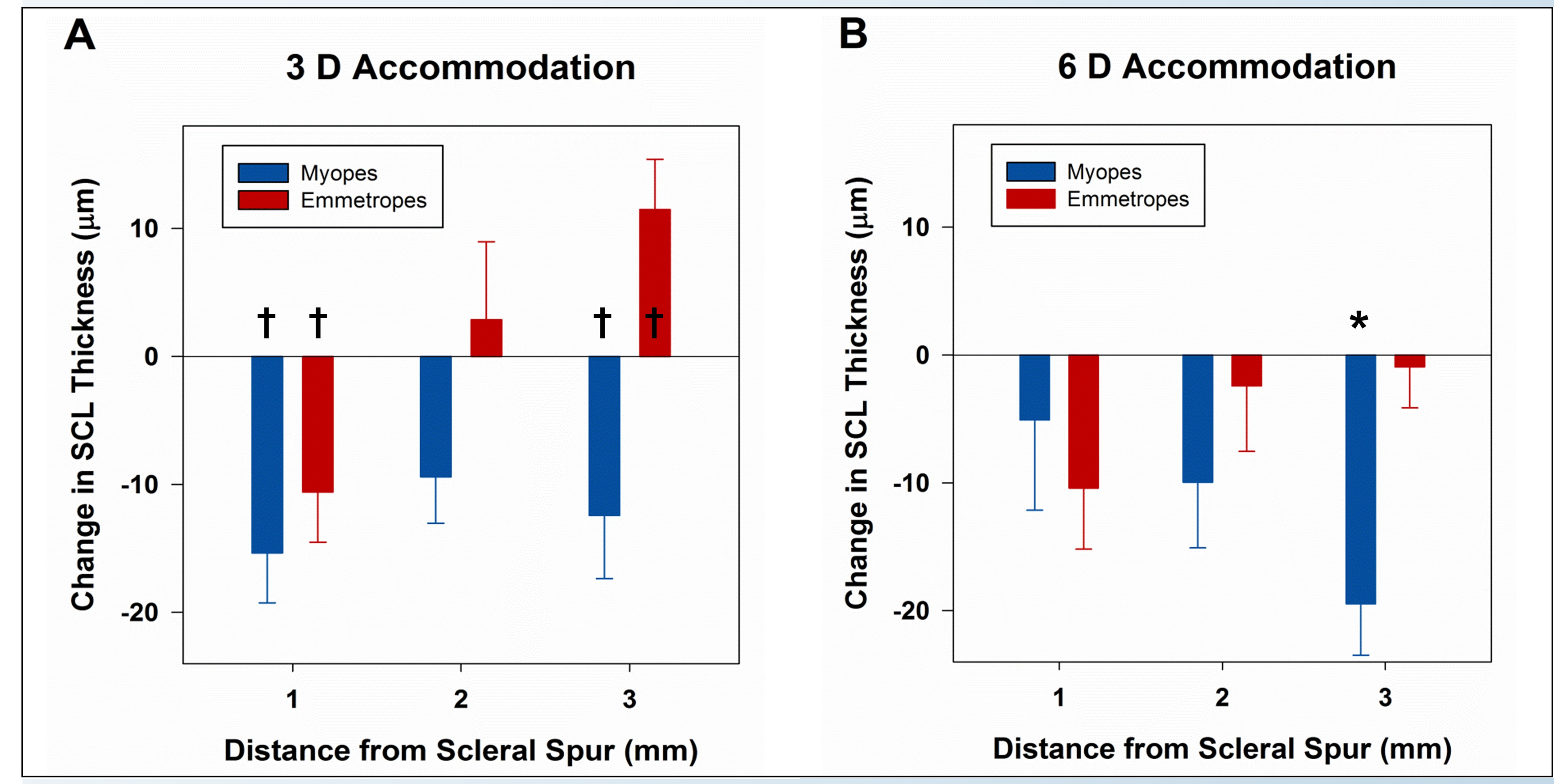

Figure 5. Change in scleral thickness (mean ± SEM, µm) from baseline at points 1, 2 and 3 mm posterior to the scleral spur in the myopic and emmetropic participants to the 3 D (A) and 6 D (B) stimulus. Crosses (†) indicate a significant change from baseline ($p < 0.05$), and asterisks (*) indicate a highly significant change from baseline ($p < 0.001$).

CONCLUSIONS

- **A significant thinning of the anterior sclera was detected during accommodation, which was more prominent in myopes, particularly 3 mm posterior to the scleral spur.**
- **The regional variations seen during accommodation between refractive groups may be associated with previously documented variations in ciliary body thickness between refractive groups,[2,3] with greater thinning seen in the scleral region overlying the thickest portion of the ciliary body for that particular refractive group.**
- **The more prominent changes seen in the myopes may be due to the altered biomechanical properties of the myopic sclera, which makes it more readily deformed under normal accommodative forces.**

REFERENCES

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2. Lewis HA, et al. Changes in ciliary muscle thickness during accommodation in children. *Optom Vis Sci* 2012, 89(5):727-737.
3. Pucker AD, et al. Region-specific relationships between refractive error and ciliary muscle thickness in children. *IOVS* 2013, 54(7):4710-4716.