Scleral Contact Lens Effects on Central and Peripheral Corneal Thickness

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Introduction:

- Scleral gas permeable contact lenses have become a more commonly utilized and essential mode of vision correction in patients with corneal diseases such as keratoconus and post-surgical corneas such as keratoplasty and radial keratotomy.
  - ♦ Basic characteristics have remain unchanged over a century, however with the evolution of new gas permeable materials and enhanced design and manufacturing features the modern scleral contact lens is vastly improved over its predecessors.
- However, even with new materials and design advances the question still lingers as to whether the cornea is receiving sufficient oxygen.
- Three recent theoretical studies using the different models arrived at the same conclusion that even scleral lenses made from high Dk material will provoke edema unless the lens is made extremely thin and the reservoir is not thicker than 150 microns. (Michaud et al 2012, Compañ et al. 2014, Jaynes et al. 2015)
  - ♦ Concern over the inherent thickness of the contact lenses, increased tear thickness and lack of tear fluid exchange has precipitated the concern that the Dk/L, or transmissibility, is insufficient in providing the cornea with required oxygen.
  - ♦ Although theoretical studies can form a basis for inquiry the real test of oxygen supply is through clinically-based research.
- Corneal hypoxia may be indirectly assessed by measuring corneal thickness through the use of a pachymeter or tomographer. Insufficient oxygen causes an increase in corneal swelling or corneal thickness.
- Literature is lacking in reports describing corneal swelling as a result of hypoxia in scleral contact lens wearers.

Purpose:

- **The current study assessed corneal thickness prior to scleral contact lens wear and after two weeks of scleral contact lens wear using a tomographic methodology to determine the presence or absence of corneal swelling**

Methods:

- 24 eyes of 16 patients were investigated in a scleral lens referral center at the Texas Eye Research and Technology Center of the University of Houston.
- Age range was from 26 to 70 years with 6 females and 10 males.
- Scleral contact lenses were made from material Dk of 100, had a diameter of 17 to 18.2mm and thickness range between 210 and 430 microns.
- Scleral contact lenses were fitted and prescribed with no conjunctival impingement, vascular blanching, corneal touch or post-lens tear thickness assessed to be less than the corneal thickness. (Figure 1, 2)
- Corneal thickness measurements were taken with a Pentacam Tomographer at the initial visit and 2 weeks after wearing the scleral contact lens. The Pentacam has been demonstrated to provide reliable and consistent readings on complex corneas. (De Sanctis et al 2008; Kamiya et al 2014)
  - ♦ Central, peripheral and apical corneal thickness measurements were recorded, as was corneal volume, which is another indicator of corneal swelling.

Results:

- All patients were successfully wearing their scleral contact lens all day (at least 8 hours).
- The mean pupillary corneal thickness pre-lens wear was 485 +/-13.1 microns (mean+/-SE) and after lens wear was 490 +/-12.6 microns. Figure 3
- Apical corneal thickness before and after lens wear was 470 +/-12.9 and 471 +/-13.4 microns respectively. Figure 4
- The inferior corneal thickness was 622 +/-26.4 and 628 +/-18.6 microns before and after scleral lens wear. Figure 5
- Corneal thickness in the superior region of the cornea was 631 +/-9.7 and 649 +/-9.4 microns before and after scleral lens wear. Figure 6
- Corneal volume was 56.9mm³ prior to lens wear and 57.9 mm³ after lens wear. Figure 7

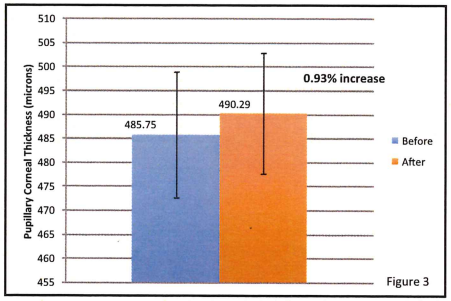

Figure 3

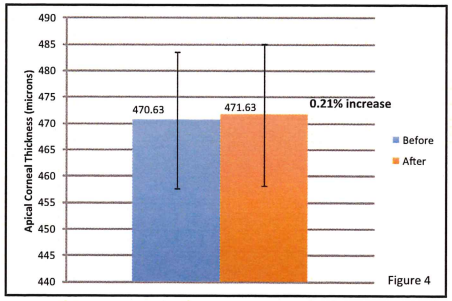

Figure 4

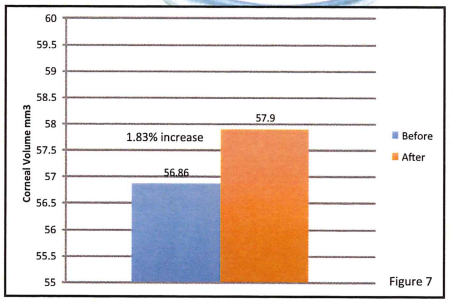

Figure 7

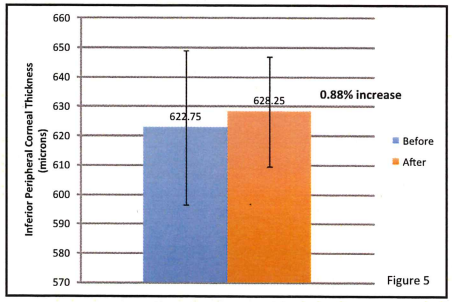

Figure 5

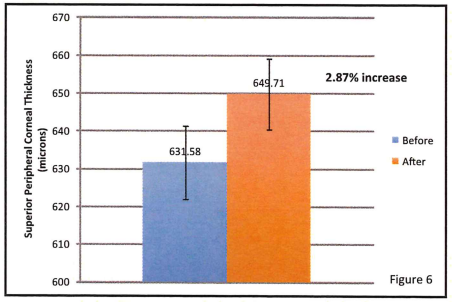

Figure 6

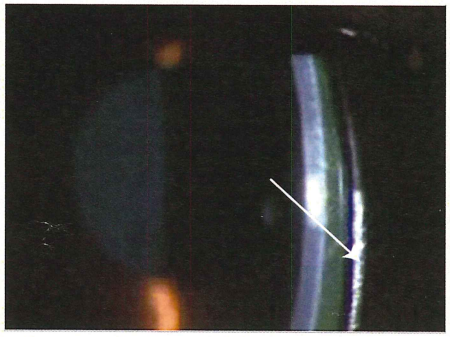
Figure 1: Tear reservoir (arrow).

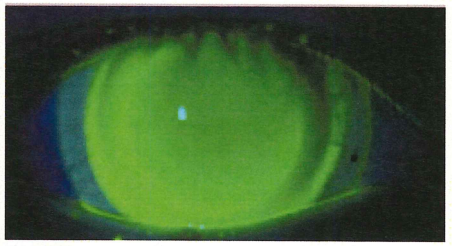
Figure 2: Scleral gas permeable contact lens with fluorescein.

Conclusions and Discussion:

- All measurements showed a minimal corneal thickness change with the greatest difference noted in the superior cornea.
- The superior cornea had a 3% corneal swelling; perhaps because this corneal region is also covered by the upper lid.
- All measurements are within what is considered normal physiological swelling following sleep. (Mertz 1980)
- Interestingly the three theoretical studies postulating hypoxia in scleral contact lens wearers predicted resultant corneal swelling within the physiological range. (less than 4%)
- **Practical and theoretical data appear to correlate suggesting minimal hypoxia in well fitted scleral lens patients.**

Acknowledgements:

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References:

- Compañ V, Oliveira C, Aguilella-Arzo M, Moliá S, Peixoto-de-Matos SC, González-Méijome JM. Oxygen diffusion and edema with modern scleral rigid gas permeable contact lenses. Invest Ophthalmol Vis Sci 55(10):6421-6429, 2014
- De Sanctis U, Loiacono C, Richiardi L, Turco D, Mutani B, Grignolo FM. Sensitivity and specificity of posterior corneal elevation measured by Pentacam in discriminating keratoconus/subclinical keratoconus. Ophthalmology 2008;115:1534-9
- Jaynes JM, Edrington TB and Weissman BA. Predicting scleral GP lens entrapped tear layer oxygen tensions. Cont Lens Anterior Eye. 38(1):44-47, 2015
- Kamiya K, Ishii R, Shimizu K, Igarashi A. Evaluation of corneal elevation, pachymetry and keratometry in keratoconic eyes with respect to the stage of Amsler-Krumeich classification. Br J Ophthalmol 2014;98:459-63
- Mertz GW. Overnight swelling of the living cornea. J Am Opt Assoc 51(3):211-214, 1980
- Michaud L, van der Worp E, Brazeau D, Warde R and Giasson CJ. Predicting estimates of oxygen tranmissibility for scleral lenses. Cont Lens Anterior Eye. 35(6):266-271, 2012