Short-term effects on local corneal thickness during the use of soft contact lenses for irregular cornea

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Introduction

Keratoconus is characterized by a presence of corneal ectasia and thinning that results in high irregular astigmatism and thereby poor vision. The correction of choice to date is made by rigid gas permeable (RGP) contact lenses. Sometimes the use of RGP contact lens becomes intolerable, because of poor comfort and stability of the lens. Other contact lens options have also been introduced, such as soft spherical and soft toric lenses, hybrid lenses, scleral lenses, and piggyback lenses. Compared to corneal RGP lenses, all these options increase the risk of reduced oxygen delivery to the cornea.[1] KeraSoft® IC lenses (Ultravision, UK) are designed to fit irregular corneas, including keratoconus, and other corneal irregularities.[2] The KeraSoft® IC is a front surface asphere or aspheric toric prism ballasted lens, available in Filcon II 3, 77% water, or Efrofilcon A, 74% water. The fitting set is supplied in 77% material.[3]

Purpose

To measure the thickness in different areas of KeraSoft® IC (Ultravision, UK) and compare it with the corneal pachymetry map of subjects wearing this kind of contact lenses, to verify the presence of induced local corneal swelling.

Methods

For each lens from the fitting set, with different BOZRs, thickness measurements were performed three times in thirteen different areas: one in the centre, four in the middle periphery and eight in the periphery. Contact lens thickness was measured by the ET-3 Electronic Thickness Gauge for Contact Lenses (Createch/ Rehder-dev Co, US). Local Dk/t was calculated, using the mean thickness in each area and the declared Dk (53×10^{-11} $(cm^2/sec)[mlO_2/(ml\times mmHg)]$)[3]

Seven subjects, aged 20-25, free of eye diseases, were fitted in the right eye with Kerasoft IC from the diagnostic set, following the fitting guide.

Pachymetry map was measured by Sheimpflug tomography (Sirius, CSO, Italy)[4], at baseline and after 4 and 8 hours of wearing of contact lenses, both in the right eye, and in the left eye (control). The values of corneal thickness, measured in the areas of the cornea corresponding to those measured on contact lenses, were compared with the values of oxygen transmissibility (Dk/t).

Results

The average thickness of the measured lenses was 400 µm, but it varied considerably depending on the lens area, from a minimum of 264 µm at the top of the lens, to a maximum of 556 µm at the bottom of the lens. Due the different thickness, the oxygen transmissibility of the lens varied from a minimum of 10 Fatt units to a maximum of 20 (average 13).

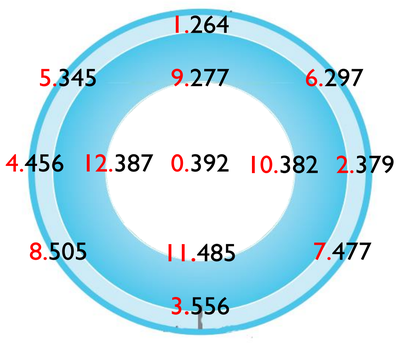


Figure 1: average thickness (µm) of the CLs in the 13 measured areas

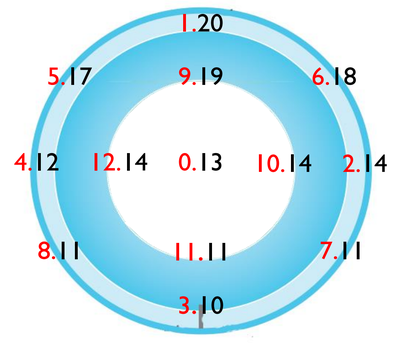


Figure 2: Calculated oxygen transmissibility (Fatt units) based on the different thicknesses

At baseline (BL) the mean central corneal thickness was 550 µm (range 523 - 610 µm), 576 µm (range 546 – 627 µm) after 4 hours and 574 µm (range 543 – 627 µm) after 8 hours. The mean corneal swelling was 3% (range 1% - 4.4%). The swelling is greater in the areas of the cornea corresponding to the thicker areas of the CL ($r^2 = 0.68$). For all the measured areas, the difference was statistically significant both between BL and after 4 hours, and between BL and after 8 hours ($p<0.001$). There were no significant differences between 4 and 8 hours, and no change in the control eye.

Zone	0	1	2	3	4	5	6	7	8	9	10	11	12
BL	555	715	712	690	656	695	716	699	656	631	612	597	585
4h	576	726	731	713	674	703	731	723	680	645	633	623	606
4h %	3,8%	1,6%	2,6%	3,3%	2,8%	1,2%	2,1%	3,4%	3,6%	2,1%	3,4%	4,4%	3,6%
8h	574	722	734	717	672	703	729	726	680	644	631	624	603
8h %	3,4%	1,0%	3,0%	3,8%	2,5%	1,2%	1,9%	3,8%	3,7%	1,9%	3,2%	4,4%	3,2%

Table 1: mean corneal thickness (µm) and corneal swelling (%) at baseline and after 4 and 8 hours of wearing

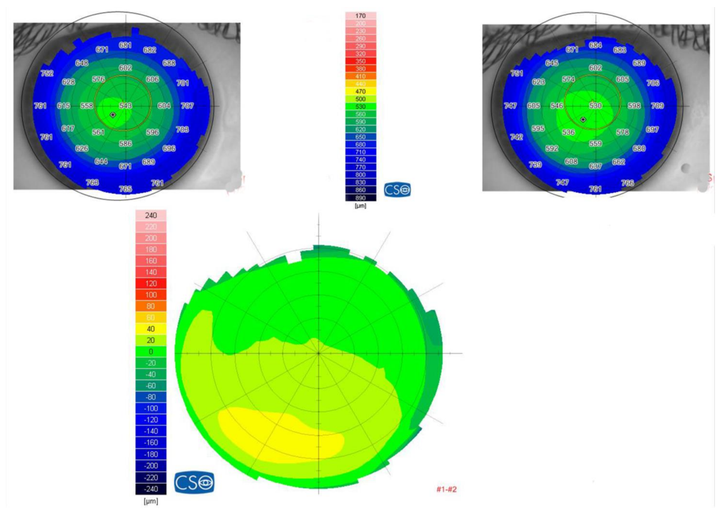
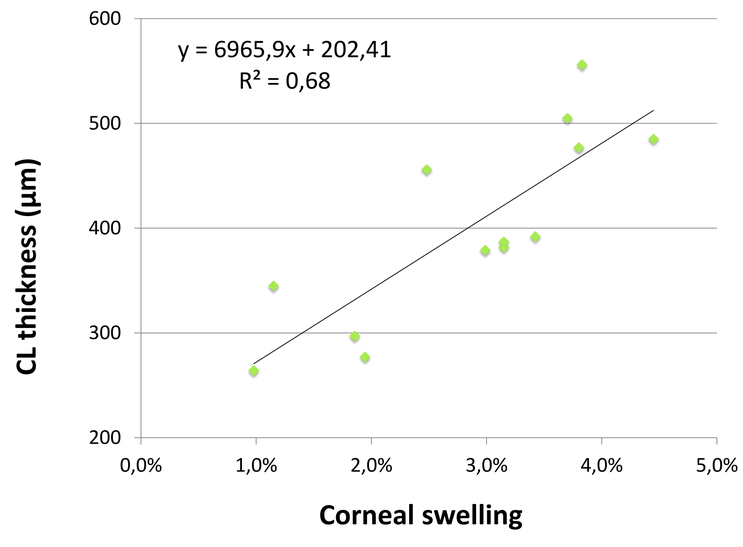


Figure 3: differential pachymetry map (in this eye the lens was rotated 10° clockwise)



Graph 1: Correlation between the thickness of the different areas of the CL and the induced swelling

Discussion and conclusion

The use of thick CLs can induce a significant corneal swelling, also in corneas of young and healthy people. The examination performed by Sheimpflug tomography is able to measure this swelling, showing local differences. Patients fitted into these lenses require consistent monitoring for any possible signs of corneal hypoxia.

References

1. Papas EB. (2014)The significance of oxygen during contact lens wear. Cont Lens Anterior Eye. Dec; 37(6):394-404.
2. Su, S., Johns, L., Rah, M. J., Ryan, R., & Barr, J. (2015). Clinical performance of KeraSoft® IC in irregular corneas. *Clinical Ophthalmology (Auckland, N.Z.)*, *9*, 1953–1964
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4. Maresca N, Zeri F, Palumbo P, Calossi A.(2014) Agreement and reliability in measuring central corneal thickness with a rotating Scheimpflug-Placido system and ultrasound pachymetry. Cont Lens Anterior Eye. Dec;37(6):442-6.