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The influence of soft contact lens wear and two weeks cessation of lens wear on corneal curvature

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ABSTRACT

Introduction: Accurate corneal measurements are crucial in corneal refractive surgery (CRS) to ensure successful outcomes. Soft contact lens (SCL) wear may result in changes to corneal curvature and structure. United States Food and Drug Administration (FDA) pre-operative guidelines recommend that prior to CRS, SCL wearers cease SCL wear for "at least two weeks before examination and treatment" [1]. Corneal curvature changes induced by SCL wear may take longer than two weeks to resolve.
Purpose: To examine the effect of SCL wear on corneal curvature before and following two weeks SCL wear cessation. To explore the possible impact of different SCL materials and years of SCL wear.
Methods: Retrospective data analysis, between a group of SCL wearers (SCL: $n = 45$); and a non-contact lens control group (NCL: $n = 45$). Corneal curvature parameters were measured using the Pentacam (Oculus, Germany), before and following two weeks cessation of SCL wear.
Results: No significant differences in keratometry or Sagittal radius of curvature between SCL and NCL groups prior to or following SCL cessation. Tangential radius of curvature showed significant inferior steepening for the SCL group prior to SCL cessation (SCL vs. NCL; 7.77 ± 0.30 mm vs. 7.90 ± 0.30 mm; $p = 0.04$). Following two weeks cessation of SCL wear this appeared to have resolved.
Conclusions: Two weeks cessation of SCL wear appears sufficient for resolution of corneal curvature changes with modern SCL materials and years of SCL wear. However, further studies with longer lens deprivation periods are required to ensure stability for all SCL wearing patients.

1. Introduction

A significant proportion of candidates for CRS wear SCLs. SCL wear can result in changes to the corneal structure and metabolism. The time required for resolution of these changes can vary according to contact lens (CL) material, modality and length of previous CL wear [2–4]. The FDA guidelines recommend that SCLs are left out for at least two weeks prior to initial consultation, however no specific guidelines are given in relation to SCL type, modality or previous years of SCL wear [1]. To the author's knowledge, no published study has examined retrospective findings from a SCL group of various lens materials and years of SCL wear and evaluated corneal stability following two weeks lens cessation, in relation to a NCL group.

Accurate corneal curvature measurements are vital prior to CRS to determine the treatment type and generate treatment plans. Corneal topography is the most sensitive pre-operative screening tool used for diseases such as forme fruste keratoconus and for contact lens-induced corneal warpage [5].

SCL wear has been found to result in significant changes to mean keratometry, corneal astigmatism and corneal eccentricity [6]. Following initial flattening of keratometry values [7], anterior corneal topography and keratometry values steepen in all corneal meridians with hydrogel SCL wear [7–10]. Increased corneal irregularity and corneal warpage or pseudo-keratoconic topography have been reported with daily wear of low oxygen transmissibility (DK/t) hydrogel SCLs [6,11,12]. High DK/t silicone hydrogel (SiH) SCLs reduce complications associated with hypoxia [13]. However, stiff modulus SiH lenses worn for longer wearing times can result in flattening of keratometry values [6,14–18].

The amount of time required to eliminate the alterations to corneal curvature is dependent on CL material, modality and years of previous SCL wear [3,4,19–21]. Corneal curvature measurements show stability following two weeks cessation of SCL wear for most patients [2]. However, in some cases, resolution of stability of corneal measurements can take weeks or months following

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cessation of SCL wear [3,16,20,21]. Resolution of alterations to curvature induced by SiH wear can take longer than three months in some cases [10,16].

The purpose of this study is to explore whether a standard SCL cessation time of two weeks, is sufficient to allow the cornea to recover from SCL wear and to assess the possible impact of a variety of modern SCL materials and years of SCL wear on corneal curvature prior to and following two weeks lens wear cessation.

2. Methods

This was a retrospective, non-masked analysis on data from a group of patients ($n = 90$), who attended a CRS clinic. Informed consent was obtained from patients to allow their data to be used anonymously for the purpose of research. This study was approved by the Ethics Committee of Dublin Institute of Technology, and it adhered to the tenets of the Declaration of Helsinki [22].

Patients attending the clinic were determined to be suitable for CRS if they achieved the suitability guidelines published by the United States FDA [1] for refractive Laser procedures. Dominant eyes only were analysed in order to account for the correlation, which exists between right and left eyes of a subject, and to avoid overstatement of the validity of statistical analysis [23–25]. Myopic prescriptions incorporating astigmatism of less than −1.50DC were included for analysis.

The full-time SCL group was comprised of patients wearing SCLs at least five days a week, for at least one year, before attending the clinic. This group was further divided according to lens material (hydrogel and SiH) and previous years of SCL wear (<5, 5–10, >10 years). The SCL group wore disposable SCLs (replaced on a daily/weekly/two-weekly or monthly basis). These groupings were based on the information relating to the most recent year of SCL wear.

The NCL group was comprised of patients with no history of CL wear. Previous RGP CL wearers and patients with a history of previous CRS were excluded from the study.

Patients were asked to cease SCL wear the evening before they attended the clinic for their first assessment. All patients in the SCL group were asked to cease SCL wear for a period of 2 weeks prior to attending the clinic for a second assessment, regardless of previous SCL material or modality of wear.

Corneal curvature analysis was undertaken using the Pentacam tomographer (Oculus, Germany). Simulated keratometry (SimK) values and Sagittal and Tangential radius of curvature values (centrally and at a 4.5 mm diameter superior and inferior to centre) were analysed. Corneal surface measurement data (curvature data, height data, Fourier analysis and Zernike analysis) are used to calculate topographical indices with the Pentcam tomographer (Oculus, Germany). These indices help in the detection of abnormalities on the corneal surface and are useful in screening patients prior to CRS. These indices were analysed for SCL and NCL groups in this study.

Corneal curvature was assessed prior to cessation of SCL wear and following two weeks lens cessation. Measurements were also repeated for the NCL group. The differences between repeated measurements from the SCL group and NCL group were examined, in order to assess whether there was more variation in corneal curvature in the SCL wearing group.

Statistical analysis was carried out using the software package SPSS 20 (SPSS Inc., Chicago, Illinois, USA). The statistical programme G*Power 3.1.2 was used to ascertain which sample size was sufficient to ensure statistical power, $n = 82$ was found to be sufficient [26].

Normality for continuous data was assessed using Shapiro–Wilks method (normal distribution when $p > 0.05$) [27]. Data that were found to have normal distribution were analysed using a two-way ANOVA. Data that did not show a normal distribution were assessed using the Kruskal–Wallis test. An alpha value of $p < 0.05$ was considered significant.

Table 1
Patient demographics showing gender, age and visual acuity (VA) data for soft contact lens (SCL) and non-contact lens control group (NCL).

	Gender % male:female	Age Mean ± SD years	LogMAR VA Mean ± SD
SCL ($n = 45$)	51:49	32 ± 7.5	−0.13 ± 0.01
NCL ($n = 45$)	64:36	37 ± 10	−0.11 ± 0.01

3. Results

All patients were of Caucasian ethnicity, see Table 1 for population demographics. The SCL group had a higher mean spherical equivalent refractive error than the NCL group (SCL: −3.73 ± 1.65DS, NCL: −2.56 ± 1.48DS, $p = 0.01$). There was no significant difference between the astigmatic refractive error between the groups (SCL: −0.58 ± 0.25DC, NCL: −0.63 ± 0.34DC, $p = 0.94$).

3.1. Patient demographics

SCLs were worn for a mean of 9 ± 4.5 years (range 1–22 years), 6.5 ± 1 days per week (range 5–7 days) and 12 ± 5 h per day (range 4–24 h) prior to consultation. Thirty-five patients wore hydrogel SCLs (77.7%), six patients wore SiH SCLs (13.3%, 3 generation 1 SiH and 3 generation 2 SiH), and four patients did not know their SCL material type (8.8%). Of the SiH group, 50% wore their lenses on an extended wear modality (24 h per day) and 50% wore their lenses as a daily wear lens (mean 12 h, range 8–16 h per day). Two subjects wore toric SCL with a cylinder correction of −0.75 (dual thin zone design) and −1.25 (accelerated stabilisation design) respectively.

3.2. Diurnal variation

Corneal curvature values can vary according to the time the measurement was taken [28], this diurnal variation pattern shows greatest changes upon awakening, with flattening of the anterior cornea and steepening of the posterior cornea evident. This pattern tends to settle as the day progresses [28]. Pentacam measurements in this study were taken during normal clinic hours (8.30–19.00 h). The time of Pentacam measurement taken at the first and second visit was analysed statistically using Mann–Whitney U testing to explore the differences in mean time of measurements between the groups (SCL vs. NCL). Results (displayed in Table 2) show there were no statistically significant differences between the groups at first or second visit.

3.3. Time of corneal thickness measurements

In order to investigate the possible effect of diurnal variation on corneal curvature values, the groups (SCL vs. NCL) were divided into morning (where measurements were taken before 14.00 h) and afternoon (where measurements were taken after 14.00 h) groups.

Table 2
Time of Pentacam measurements. Mean ± SD and results of Mann–Whitney U testing for the time of Pentacam measurements taken at first visit and second visit ($p < 0.05$).

Time of measurement	SCL group ($n = 45$)	NCL group ($n = 45$)	p-Value
First visit (h)	12.66 ± 2.55	12.44 ± 2.91	0.455
Second visit (h)	13.56 ± 2.70	13.59 ± 2.90	0.932