# Influence of soft contact lens material on corneal warpage: prevalence and time to resolution

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## ABSTRACT • RÉSUMÉ

**Objective:** Corneal warpage represents a reversible distortion of the corneal surface induced by soft contact lens (SCL) wear. The aim of the study is to assess the influence of SCL materials, age, wearing duration, cylindrical refraction, and spherical equivalence on the prevalence and time to resolution of corneal warpage.

**Methods:** This is an interventional prospective study in which SCL wearers volunteered to remove their SCLs and underwent, on each visit, a corrected distance visual acuity and anterior and posterior segment evaluation, along with keratometry measurement and corneal topography. Visits were scheduled 30 minutes after SCL removal, on day 4, day 7, and then weekly after SCL removal until warpage resolution.

**Results:** A total of 17 volunteers (34 eyes) were included, with 9 (18 eyes) in the hydrogel SCL group and 8 (16 eyes) in the silicone hydrogel SCL group. The difference in warpage prevalence between the hydrogel group (28%, 5 eyes) and silicone hydrogel group (31%, 5 eyes) was not statistically significant ($p > 0.90$). Duration necessary for warpage resolution ranged from 7 to 21 days with no statistically significant difference between the 2 groups ($p = 0.12$).

**Conclusions:** Both types of SCL had similar corneal warpage prevalence and time to resolution, with slightly longer mean time to resolution with silicone hydrogel. All eyes had resolution of warpage by 3 weeks. It seems more cautious to wait longer than the usual 1-week interval before performing refractive surgery, especially in patients wearing SCL for long periods and regardless of the type of material.

**Objet :** La déformation cornéenne constitue une distorsion réversible de la surface de la cornée provoquée par les lentilles cornéennes souples (LCS). La présente étude avait pour objectif d'évaluer l'effet des matériaux des LCS, de leur âge, de la durée de port des lentilles, de la réfraction cylindrique et de l'équivalence sphérique sur la prévalence et le délai de disparition de la déformation cornéenne.

**Méthodes :** Il s'agit d'une étude d'intervention prospective au cours de laquelle des sujets porteurs de LCS ont accepté de les retirer pour subir un certain nombre d'examens: acuité visuelle de loin corrigée, évaluation des segments antérieur et postérieur, kératométrie et topographie cornéenne et ce, à chaque visite. Les mesures ont eu lieu 30 minutes après le retrait des LCS, le jour 4, le jour 7, puis une fois par semaine après le retrait des LCS, jusqu'à disparition de la déformation cornéenne.

**Résultats :** Au total, 17 volontaires (34 yeux) ont été inclus, dont 9 (18 yeux) faisaient partie du groupe LCS en hydrogel et 8 (16 yeux), du groupe LCS en silicone hydrogel. La différence entre les 2 groupes quant à la prévalence de déformation cornéenne n'était pas statistiquement significative ($p > 0{,}90$): 28 % (5 yeux) dans le groupe hydrogel et 31 % (5 yeux) dans le groupe silicone hydrogel. Le délai de disparition de la déformation cornéenne s'échelonnait de 7 à 21 jours, et on n'a noté aucune différence statistiquement significative entre les 2 groupes ($p = 0{,}12$).

**Conclusions :** La prévalence de déformation cornéenne a été semblable avec les deux types de LCS. Le délai de résolution de la déformation était comparable dans les deux groupes, quoique légèrement plus long dans le cas des LCS en silicone hydrogel. La déformation avait disparu dans tous les yeux après 3 semaines. Il semble donc plus prudent de prolonger davantage le délai d'attente habituel de 1 semaine avant de réaliser une chirurgie réfractive, surtout chez les patients qui portent leurs LCS pendant de longues périodes, et ce, peu importe le type de LCS.

Warpage is a reversible distortion of the cornea induced by chronic contact lens wear[1,2] that might alter the stability of preoperative refraction and subsequently affect the outcome of refractive surgery.[3] This distortionis reversible, but the time to resolution is variable among individuals[4,5] and seems to be affected by the oxygen permeability (Dk, from German: Diffusionskonstante), thickness, and elasticity module of the contact lens.[1,2,6–9]

Soft contact lenses (SCLs) have been available for many years and are essentially made of hydrogel (H) or silicone hydrogel (SH).[10] SH-SCLs have been shown to be more tolerable to the ocular surface and therefore to provide more comfort to their wearers than do H-SCLs.[1] However, to our knowledge, the effect of modern SCL materials on corneal warpage has not been thoroughly studied.

The aim of this study is to compare the effect of 2 different SCL materials, SH and H, on the prevalence and time to resolution of corneal warpage. The influence of other factors, such as age, SCL wear duration, cylindrical refraction, and spherical equivalence, on corneal warpage is also assessed.

## Materials and Methods

This is an interventional prospective study that included volunteer SCL wearers who presented to the ophthalmology


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**Table 1—Inclusion criteria**

| Inclusion criteria |
|---|
| • Diurnal SCL wearer |
| • SCL wear for at least 3 months |
| • Wearing of SCL for at least 6 hours/day |
| • Age between 21 and 65 years |
| • Refractive spherical equivalent between −2.00 and −8.00 D with a cylinder ≤3.00 D |

SCL, soft contact lens.

clinic of Hôtel-Dieu de France hospital (Beirut, Lebanon) between December 2014 and December 2015. This study was approved by the Hôtel-Dieu de France Ethics Committee and complied with the Declaration of Helsinki. A complete explanation of the procedure was given and an informed consent from all subjects was signed before initiation of the study.

The inclusion[3,4] and exclusion[3,4,11] criteria were chosen to meet the characteristics of refractive surgery candidate population as much as possible (Tables 1 and 2). Eligible volunteers were asked to fill out a questionnaire about their demographic characteristics and contact lens wear habits (see Appendix 1, available online).

Subjects had to remain without their lenses for the entire duration of the study. All volunteers underwent a complete visual examination comprising a corrected distance visual acuity (CDVA), anterior and posterior segment evaluation, keratometry measurement, and corneal topography (Tomey TMS 4, Phoenix, Ariz.) 30 minutes after SCL removal. The same examinations were repeated on days 4 and 7 and then weekly until warpage resolution. Patients who missed a follow-up were excluded from the study. All patients were asked to return at the same time on each visit to control for the diurnal variation of the topography results.[12–14] All topographies were interpreted by the same investigator (N.W.), who was blinded to the type of SCL.

**Table 2—Exclusion criteria**

| Exclusion criteria |
|---|
| • Previous surgery or trauma to the eye |
| • Corneal diseases such as keratoconus, corneal dystrophies, or allergy |
| • History of autoimmune or collagen vascular disease |
| • Patients taking isotretinoin or amiodarone |
| • History of herpes simplex or herpes zoster keratitis |
| • Diabetes mellitus |

**Table 3—Criteria for assessing warpage resolution**

| Method of Assessment | Criteria for Stabilization (Compared to Last Visit's Measurement) |
|---|---|
| Manifest refraction | Spherical equivalent with <0.50 D change; cylindrical refraction with <0.50 D change |
| Keratometry | Keratometry with <0.50 D change in both the horizontal or vertical axis |
| Corneal topography | <0.50 D change within the central 3 mm cornea in both the steep and the flat meridians |

**Table 4—Demographic and refractive characteristics of the volunteers**

| Candidates' Characteristics | SH-SCL Group | H-SCL Group | *p* |
|---|---|---|---|
| Sex ratio, M:F | 1:3 | 1:2 | 0.72 |
| Mean age ± SD, years | 22.63 ± 1.71 | 23.61 ± 2.59 | 0.20 |
| Years of SCL wearing ± SD | 5.63 ± 2.69 | 6.89 ± 2.80 | 0.19 |
| Days per week of SCL wearing ± SD | 6.25 ± 0.45 | 6.22 ± 0.43 | 0.86 |
| Hours per day of SCL wearing ± SD | 10.50 ± 1.53 | 10.67 ± 0.98 | 0.76 |
| Mean spherical equivalent ± SD | 3.83 ± 1.89 | 3.73 ± 1.73 | 0.92 |
| Mean cylindrical refraction ± SD | 0.44 ± 0.54 | 0.50 ± 0.53 | 0.74 |

SH-SCL, silicone-hydrogel soft contact lens; H-SCL, hydrogel soft contact lens; SD, standard deviation.

**Table 5—Frequency of corneal warpage and mean time to resolution depending on the type of SCL**

| | SH-SCL Group | H-SCL Group | *p* |
|---|---|---|---|
| Warpage present | 31% | 28% | >0.90 |
| Time to resolution (days) | 17.20 ± 3.56 | 11.20 ± 6.26 | 0.12 |

SH-SCL, silicone-hydrogel soft contact lens; H-SCL, hydrogel soft contact lens.

Corneal warpage was defined as the presence of at least one of the following criteria:

1. Presence on topography of irregular astigmatism, loss of radial symmetry, and/or reversal of the normal topographic pattern of progressive flattening of the corneal contour from the centre to the periphery.[15]
2. Not meeting the criteria for corneal stabilization between 2 consecutive visits detected by at least one of the 3 examinations: subjective refraction, keratometry, and topography (Table 3).[4]

Statistical analysis was done using SPSS version 20.0. Descriptive statistics were reported as mean and standard deviation for continuous variables. Fisher and *t* tests were used to compare qualitative and quantitative variables, respectively. The Wilcoxon rank test was used to compare the time to resolution between SCL materials. A *p*-value $<0.05$ was considered to be statistically significant

## Results

Among the 19 volunteers, 2 were excluded for taking isotretinoin as treatment for severe acne. Nine volunteers

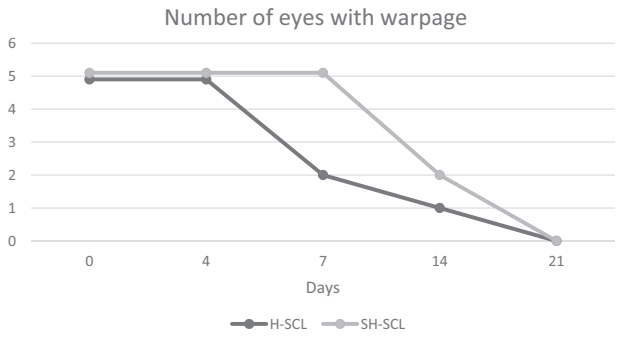


**Fig. 1—Time to resolution of corneal warpage in both groups.**