Effect of contact lens wear on the anatomic values of the corneal thickness

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SUMMARY

The aim was to analyze the changes in central corneal thickness values due to soft contact lens wear. We analyzed the central corneal thickness values (baseline measurements) of 15 myopic adolescent soft contact lens wearers (15 eyes; aged 15 to 16 years old). Three years later, the central corneal thickness was measured again. We also measured the central corneal thickness of 31 myopic adolescents who did not use contact lenses (31 eyes; aged 15 to 16 years old) and 34 myopic contact lens wearers aged between 25 and 40 years old (34 eyes). We obtained the mean of five measurements using the Orbscan Topography System II (Orbscan, Inc., Salt Lake City, UT, USA). In the later measurements (three years) there was a significant decrease in the central corneal thickness values (p=0.012) of the adolescent contact lens wearers and the contact lens subjects aged 25 to 40 years old (p<0.001). This decrease was not found in the adolescent non-contact lens wearers (p=0.476). The central corneal thickness values of the adolescent contact lens wearers were significantly lower than the baseline values up to four weeks after removal of their contact lenses (p=0.201). In conclusion, there was a significant reduction in the anatomic values of corneal thickness associated with soft contact lens wearers, although baseline thickness values recovered to normal levels approximately one month after the use of contact lenses had ceased.

Key words: Cornea – Corneal thickness – Pachymetry

INTRODUCTION

Some studies have observed that long-term contact lens wear is associated with a reduction of corneal thickness values (Liu and Pflugfelder, 2000; Braun and Anderson-Penno, 2003; Sanchis-Gimeno et al., 2003).

Patients usually start to use soft contact lenses during adolescence. Nevertheless, to our knowledge, to date no study has addressed the changes in the anatomic values of the corneal thickness of soft contact lens wearers during adolescence.

In this report we wanted to analyze the changes in the anatomic corneal thickness values of subjects who started to use soft contact lenses during adolescence.

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MATERIAL AND METHODS

We measured central corneal thickness (CCT) in 80 eyes of 80 subjects. Participation was voluntary and informed consent was obtained after the subjects had been provided with information about the nature of the study.

We obtained the mean of five consecutive measurements of CCT by means of Orbscan pachymetry (Orbscan Topography System II, Orbscan, Inc., Salt Lake City, UT, USA) with an acoustic equivalent factor of 0.92 as recommended by the manufacturer (Sanchis-Gimeno et al., 2003, 2004). Examinations were carried out from 6 p.m. to 7 p.m.

The Orbscan system measures anterior and posterior corneal elevation (relative to a best-fit sphere), surface curvature, and corneal thickness values using a scanning-slit mechanism. The corneal thickness value is obtained by the differences in elevation between the anterior and posterior surfaces of the cornea. The images of the cornea are taken using a placido disc and are shown on the screen of the instrument. During examination, the patient's chin leans on the chin rest and the forehead rests against the forehead strap. Our subjects were asked to look at a blinking red light coaxial to the imaging system, while the tracking system measured involuntary eye movements during the examination.

We made up one group of 15 myopic subjects (15 eyes; aged 15 to 16 years old) who had not previously worn contact lenses. These subjects (soft contact lens group) started to use conventional soft contact lenses (soft contact lens alphafilcon A, 66% water; full-time wear) after the baseline measurements. In addition, we made up another group of 31 myopic subjects (non-soft contact lens group; aged 15 to 16 years) who used eyeglasses before and after the baseline measurements. The subjects in this group (non-soft contact lens group) had never worn contact lenses before and did not wear them after the baseline measurement.

The CCT was measured again three years later (40.4 ± 1.3 months; range, 37 to 42 months) in both groups. The adolescent contact lens wearers were required to remove their contact lenses and to use eyeglasses. The CCT of these subjects was measured 2 and 4 weeks after removing the contact lenses in order to analyze the possibility of recovery of the baseline CCT values after they had ceased to use contact lenses. We also obtained the CCT values from the charts of 34 myopic contact lens wearers (soft contact lens alphafilcon A, 66% water) aged between 25 and 40 years old (34 eyes; mean age, 29.4 ± 3.2). We recorded the baseline values and the values three years later.

Our aim was to analyze the possibility of recovering the adolescents' baseline CCT values after they had ceased to use contact lenses. Following on from this, we recommended that the adolescent contact lens wearers should use eyeglasses.

The Kolmogorov-Smirnov test and Student's t-test were applied. P values of less than 0.05 were considered to be statistically significant.

RESULTS

The characteristics of the adolescents analyzed are summarized in Table 1. There were no significant differences in manifest spherical equivalent refraction between the contact and the non-contact lens wearers at the beginning of the study (p=0.448). Neither were the differences significant three years later (p=0.487). There were no significant differences in applanation tonometry between the contact and non-contact lens wearers before (p=0.816) and three years later (p=0.885).

Table 1. Characteristics of the adolescents analyzed.

	Baseline		3 years later	
	CLG *	NCLG †	CLG *	NCLG †
n	15	31		15 31
Mse (diopters) ‡	-3.3±1.6	-3.2±1.2	-3.4±1.4	-3.5±1.7
BCVA = 20/22 §	9 (60.0%)	25 (80.6%)	9 (60.0%)	25 (80.6%)
GAT (mm Hg) ⌐	14.1±1.4	14.2±2.1	14.3±1.5	14.3±2.0

* Contact lens group; † Non contact lens group; ‡ Mean spherical equivalent refraction; § BCVA, Best corrected visual acuity; ⌐ GAT, Goldmann applanation tonometry.

The characteristics of the subjects aged between 25 and 40 years old are summarized in Table 2.

Table 2. Characteristics of the subjects between 25 and 40 years old.

	Baseline	3 years later	p-value
n	34	34	
Mse (diopters) *	-3.14±2.4	-3.26±2.1	0.298
BCVA = 20/22 †	22 (64.7%)	21 (61.76%)	——
GAT (mm Hg) ‡	16.9±1.7	17.11±2.2	0.567

* Mean spherical equivalent refraction; † BCVA, Best corrected visual acuity; ‡ GAT, Goldmann applanation tonometry

Table 3 shows the results of the CCT measurements obtained in both groups of adoles-

cents. Table 3 also presents the CCT values of the contact lens subjects aged between 25-40.

Table 3. Central corneal thickness values of the subjects analyzed (mean microns±SD).

	Baseline	3 years later	p-value *
Non-contact lens adolescents	554±11.4	552±11.3	0.476
Contact lens adolescents	552±7.14	545±8.35	<0.012 †
Contact lens aged 25-40 years old	550±9.40	539±8.81	<0.001 †

* Student's t-test
† Statistically significant

Table 4 shows that the CCT values of the adolescent contact lens wearers were significantly lower than the baseline values up to four weeks after removing the lenses.

Table 4. Recovery of the baseline central corneal thickness values of the soft contact lens adolescents after ceasing contact lens use (micrometers).

Control period	mean±SD	p-value *
Before starting to use contact lenses	552±7.14	
Two weeks after removing the contact lenses	545±8.35	0.012 †
Four weeks after removing the contact lenses	549±7.32	0.201

* Student's t-test
† Statistically significant

DISCUSSION

We found a reduction in CCT values in the full-time soft contact lens wearer group that was not found in the non-contact lens wearer group. Nevertheless, the baseline CCT values recovered after the subjects had ceased to use contact lenses.

We carried out the CCT measurements using the Orbscan instead of the more common ultrasound pachymetry. Since the introduction of Orbscan pachymetry (Yaylali et al., 1997) there has been controversy about the differences in CCT values obtained with ultrasound and Orbscan pachymetry. Different studies have found that Orbscan CCT measurements carried out without an acoustic equivalent factor of 0.92 are approximately 20 to 55 microns higher than ultrasound CCT values (Yaylali et al., 1997; Modis et al., 2001). However, we used the Orbscan with an acoustic equivalent factor of 0.92, since it is known that there are no significant differences between Orbscan and ultrasound pachymetry when the Orbscan measurements are carried out using this acoustic equivalent factor (Fakhry et al., 2002; Suzuki et al., 2003). Thus, the results we obtained may be similar to those obtained by means of ultrasound pachymetry. However, the use of a single cor-

rection factor across the entire cornea must be accepted with reservations when a constant linear relationship between ultrasound and Orbscan pachymetry has not been proved (Cairns and Mcghee, 2005). Moreover, some authors (Iskander et al., 2001), using the Orbscan II with an acoustic equivalent factor of 0.92, have detected large discrepancies between corneal pachymetric measurements obtained by ultrasound and Orbscan pachymetry. They conclude that ultrasound pachymetric measurements are more accurate than Orbscan pachymetric measurements.

There were no significant differences in age, spherical equivalent refraction or tonometry during the first (baseline) and the second corneal thickness measurements (three years later) between the soft contact lens group and the non-contact lens group. Neither were there any differences between the groups in baseline corneal thickness values. However, three years later the differences were significant. Nevertheless, no corneal injuries apart from contact lens overuse were reported, and we found no pathology that could cause thinning of the cornea (i.e. keratoconus). The only difference between the baseline and the second corneal thickness measurement was the use of soft contact lenses. Therefore seems that full-time soft contact lens wear is the cause of the reduction in corneal thickness values obtained in the second corneal thickness measurements of the soft contact lens wearers.

In a retrospective study that included full-time soft contact lenses wearers for 2 years or more, Braun and Anderson-Penno (2003) observed a mean reduction in CCT values of 22 microns in their soft contact lens group as compared to the control population. Two different studies (Liu and Pflugfelder, 2000; Sanchis-Gimeno et al., 2003) that compared the corneal thickness values of contact lens wearers and non-contact lens wearers detected a mean decrease in the corneal thickness values of the contact lens wearers of 30 to 50 microns (Liu and Pflugfelder, 2000) and of 14 to 30 microns (Sanchis-Gimeno et al., 2003).

One explanation for the reduction in the CCT values three years after starting contact lens wear could be a consequence of epithelial thinning (Liesegang, 2002). It has been suggested that with extended wear of soft contact lenses the epithelium is thinned by 6% on average (Liesegang, 2002).

The cornea is 78% water, and the stroma constitutes 90% of the thickness of the cornea

(Liesegang, 2002). Another possible explanation for the reduction in corneal thickness values may be stromal thinning.

Stromal thinning can occur in patients who have worn contact lenses for years (Liesegang, 2002). Thinning by 2% may be a sequel to chronic stromal edema correlated with the degeneration and possible death of stromal keratocytes. Immediately after contact lens removal, stromal thinning is masked by the superimposed edema; the thinning becomes apparent only 2 days after cessation of contact lens wearing (Liesegang, 2002).

Chronic edema induces morphologic changes in the stromal keratocytes, manifesting as functional changes in the ability of these cells to synthesize collagen, glycoproteins, and proteoglycans. The causes of corneal thinning probably involve the loss of stromal keratocytes (Braun and Anderson-Penno, 2003; Liesegang, 2002), which synthesize the collagen, glycoproteins, and proteoglycans that constitute the bulk of stromal tissue (Braun and Anderson-Penno, 2003). Apoptosis of keratocytes may be attributed to chronic hypoxia or the release of mediators such as interleukin-1 from traumatized corneal epithelial cells (Braun and Anderson-Penno, 2003).

Another possible cause is dissolution of stromal tissue, caused by an accumulation of lactic acid in the cornea secondary to chronic hypoxia, resulting in the loss of mucopolysaccharide ground substance (Braun and Anderson-Penno, 2003; Liesegang, 2002).

Another factor may be the increased tear osmolarity in subjects wearing contact lenses because chronic exposure to a hyperosmotic tear film has been reported to be able to induce generalized corneal thinning (Liu and Pflugfelder, 2000).

In sum, perhaps the most significant finding of our study is that following full-time soft contact lens wear during adolescence base-line CCT values can be recovered after subjects have ceased to use contact lenses.

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