Original Article

Clinical Performance and Patient Satisfaction of Hybrid Contact Lenses in Patients with Keratoconus

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Abstract

Objectives: The aim of the study was to evaluate the fitting process, clinical performance, and patient satisfaction of hybrid contact lenses (HCL) in patients with keratoconus (KC).

Materials and Methods: Sixty-eight KC patients (35 female, 33 male) who were prescribed HCL were included in the study. Corneal topographic parameters, best corrected visual acuity (BCVA) with eyeglasses, the number of HCL trials, prescribed HCL base curve (BC), and visual acuity with HCL were recorded from hospital records. A contact lens satisfaction survey was sent to the patients via email or WhatsApp and the data was statistically analyzed using IBM SPSS Statistics version 22.0.

Results: The study included 110 eyes of 68 patients with a mean age of 27.34±8 years (range: 12-48 years). According to the Amsler-Krumeich classification, 35.5% of the eyes were stage 1, 50.9% were stage 2, and 13.5% were stage 3 or 4. Mean K1, K2, and K_{mean} values were 7.14±0.50 mm (range 5.72-8.30 mm), 6.63±0.49 mm (range 5.07-7.84 mm), and 6.89±0.48 mm (range 5.39-8.06 mm), respectively. The average number of lens trials was 1.59±0.82 (range 1-4). The mean BC of the prescribed HCL was 6.84±0.50 mm (range 5.60-8.00 mm). BCVA with glasses was 0.36±0.2 (range 0.05-0.8), and 0.80±0.14 (range 0.3-1.0) with HCL ($p<0.0001$). The overall survey score was 3.54 out of 5, the overall satisfaction score was 3.27, the average vision satisfaction score was 3.62, the average satisfaction score for lens insertion and removal was 3.01, and the average satisfaction score for lens comfort was 2.97.

Conclusion: Prescribed HCL BC is usually close to the topographic K_{mean} value and in most of the patients, fitting was successful with the first or second CL trial. The overall satisfaction score was moderate to good and the disadvantages were low comfort compared to soft CL, difficulty with insertion and removal, short lens life, and high cost.

Keywords: Keratoconus, hybrid contact lens, contact lens satisfaction, survey

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Introduction

Keratoconus (KC) is a non-inflammatory, progressive ectatic disorder characterized by protrusion and thinning of the cornea.[1,2] The disease is initially asymptomatic, with irregular astigmatism, progressive myopia, corneal thinning, and reduction in visual acuity (VA) developing over time. Although KC is usually bilateral, it can also be asymmetrical, and onset in the fellow eye can occur years later.[1] The goal of treatment is to halt disease progression and improve vision quality. Corneal cross-linking therapy is performed in cases of progressive KC.[3] There are many different contact lens (CL) options for visual rehabilitation in KC patients. Although soft spherical/toric CLs improve vision in the early stages, the use of lenses such as corneal rigid gas-permeable CL, piggyback CL, hybrid CL (HCL), and scleral lenses are required in the intermediate and advanced stages.[4]

In the 2015 Global Consensus on KC report, rigid gas-permeable CLs were recommended in cases where glasses and soft CLs do not adequately increase vision.[4] Although rigid gas-permeable CLs significantly increase visual acuity, they cannot be tolerated by some patients. They also have drawbacks such as decentration in very steep and irregular corneas, falling out of the eye easily, and leading to apical corneal scar because of friction.[5,6,7] This led to the development of HCLs, which combine the optical correction of rigid lenses and the comfort of soft lenses.[8] HCLs consist of a rigid gas-permeable material at the center surrounded by a soft peripheral skirt. The Saturn II (Precision-Cosmet, USA) and SoftPerm (Sola/Barnes-Hind Incorporated, USA) were first-generation HCLs introduced in the 1980s. However, first-generation HCLs were not popular with patients due to their low oxygen permeability, unstable rigid-soft material interface, and uncomfortable lens wear.[8,9,10] The UltraHealth (SynergEyes Inc, Carlsbad, CA, USA), EyeBrid (LCS, Cane, France) and Airflex (SwissLens, Prilli, Switzerland) are next-generation HCLs that have silicon-hydrogel polymer

skirts with high oxygen permeability.[11] They are easier to apply than first-generation HCLs, significantly improve vision quality, and offer fairly good patient comfort.[12,13,14,15,16]

The aim of this study was to evaluate the HCL fitting process, average number of CL trials required to prescribe appropriate lenses, clinical performance, and patient satisfaction in KC patients who underwent HCL fitting and prescription in our clinic and continued to use them.

Materials and Methods

The study was conducted in accordance with the principles of the Declaration of Helsinki after obtaining approval from the Selçuk University Faculty of Medicine Ethics Committee (decision no: 2020/13). A total of 68 patients who were prescribed an HCL for KC in our clinic were included in the study. Patients with ectatic diseases other than KC such as pellucid marginal degeneration or keratoglobus, patients with a history of corneal hydrops, patients with severe corneal opacity, and patients undergoing keratoplasty were not included in the study.

The patients' age, sex, previous cornea cross-linking therapy, previous CL use, brand of CL used previously, best corrected VA (BCVA) on Snellen chart with glasses and the HCL, keratometry values (K1, K2, K_{mean} [average of K1 and K2]), number of lens trials, brand of HCL prescribed, and its base curve were noted from the patients' records.

Our clinic has EyeBrid silicone (LSC, France) and Airflex (Swisslens, Prilly, Switzerland) HCL trial sets. These lenses are made for 6-month use and have the same material and design characteristics (Table 1). They provide effective refractive correction due to the rigid central optic that has high oxygen permeability (Dk: $100x10^{-11}$). The silicone hydrogel soft skirt (Dk: $50x10^{-11}$) stabilizes the lens and increases patient comfort. The HCLs used for KC have two major designs: vaulted lens designs (Clearkone and UltraHealth) and designs bsased on the base curve (SynergEyes KC, EyeBrid, Airflex). In terms of fitting technique, there are differences between the two designs. Vaulted lens designs require a more detailed method in which the rigid lens and soft skirt parameters are calculated separately, whereas with base curve designs, fitting is done more easily using the curve of the rigid gas-permeable lens. The EyeBrid Silicone and Airflex both have base curve designs, and the fitting principles are similar to those of corneal lenses. These lenses also have a choice of four skirt curves for each base curve.

Patient Survey

Patients whose phone numbers were available from the hospital records were called and informed about the study. After obtaining their verbal consent, they were asked to complete a CL satisfaction survey. Patients who agreed to participate in the study were sent the questionnaire via email or their phone via WhatsApp.

The satisfaction questionnaire used in this study was created by modifying two previously validated questionnaires (Contact Lens Impact on Quality of Life, Contact Lens Dry Eye Questionnaire) (Appendix 1).[13] The questionnaire included general questions about the HCL brand, duration of use, and previous CL use, followed by items evaluating 4 categories: the comfort, difficulty with insertion/removal, visual quality, and general satisfaction with the HCL used (Appendix 1). Responses were scored from 1 to 5. During evaluation, scores for negative questions were adjusted to 1 for the most negative and 5 for the most positive.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics 22 (IBM Corp., Armonk, NY, USA) software. Descriptive statistics were expressed as mean ± standard deviation and range (minimum-maximum) for variables with normal distribution, median and range for variables without normal distribution, and number and percentage for nominal variables. Shapiro-Wilk and Kolmogorov-Smirnov tests were used to determine whether the variables were normally distributed. Relationships between continuous variables with normal distribution were evaluated using Pearson correlation analysis. The significance of the differences in group means was investigated with Student's t-test for independent samples, the significance of differences between the medians of dependent samples was investigated with the Wilcoxon test, and the significance of differences in median values between independent groups was investigated with the Mann-Whitney U test. For comparisons between more than two groups, the significance of the difference in means was investigated using analysis of variance (ANOVA) and the significance of the difference in terms of median values was investigated using the Kruskal-Wallis test. $P<0.05$ was considered statistically significant.

Table 1. Specific features and current parameters of base curve-based new-generation HCLs

Material + UV protection	Soft skirt: Filcon V3 (colorless) Rigid gas-permeable central zone: Roflufocon D (blue)
Water content	Silicone hydrogel 50%
Dk	Rigid gas-permeable central zone: $100x10^{-11}$ (ISO/Fatt) Soft skirt: $50x10^{-11}$ (ISO/Fatt)
Central thickness	0.20 mm
Design	Spheric and back/front/bi-toric
Overall diameter	14.90 mm
RGP diameter	8.50 mm
Base curve	5.50 to 10.00 mm in 0.05 mm steps
Soft skirt J-index	J 0.0 (standard skirt) -0.5 to +1.0 in 0.5 steps
Diopters (D)	Spherical: -40.00 to +40.00 D in 0.25 D steps Cylindrical: -0.50 to -6.00 D in 0.25 D steps on all axes

UV: Ultraviolet, RGP: Rigid gas-permeable. Source: Harbiyeli II, Erdem E, Isik P, Yagmur M, Ersoz R. Use of new-generation hybrid contact lenses for managing challenging corneas. Eur J Ophthalmol. 2021;31:1802-1808.

Results

This study included 110 eyes (60 right eyes, 50 left eyes) of 35 women (51.5%) and 33 men (48.5%) with a mean age of 27.34±8 years (range, 12-48 years) (Table 2). Mean age did not differ significantly by sex (p=0.28). Corneal cross-linking therapy had been performed in 59.1% of the eyes, and 14 patients (20.6%) had previously used corneal a rigid gas-permeable CL. The patients' mean K1 value was 7.14±0.50 mm (range 5.72-8.30 mm), K2 value was 6.63±0.49 mm (range 5.07-7.84 mm), and K_{mean} value was 6.89±0.48 mm (range 5.39-8.06 mm). According to the Amsler-Krumeich classification, 35.5% of the eyes were stage 1, 50.9% were stage 2, and 13.5% were stage 3-4 (Table 3). The mean number of lens trials per patient required to prescribe an appropriate HCL was 1.59±0.82 (range 1-4). Fitting was successful in the first trial in 59.1%, the second trial in 26.4%, the third trial in 10.9%, and the fourth trial in 3.6%. There was no significant difference in the number of CL trials according to KC stage (Kruskal-Wallis test, p=0.87).

Seventy eyes were prescribed Airflex® (63.6%) and 40 eyes were prescribed EyeBrid® (36.4%). The mean base curve of the prescribed HCL was 6.84±0.50 mm (range 5.60-8.00 mm). The prescribed HCL was equal to K_{mean} in 43 eyes (39.1%), steeper than K_{mean} in 46 eyes (41.8%), and flatter than K_{mean} in 21 eyes (19.1%) (Table 4).

The mean BCVA with glasses was 0.36±0.2 decimal (range 0.05-0.8; 0.53±0.32 LogMAR), and the mean BCVA with HCL was 0.80±0.14 decimal (range 0.3-1.0; 0.10±0.09 LogMAR) (Wilcoxon test, p<0.0001). VA was evaluated according to KC stage. BCVA with glasses was significantly higher in stage 1 than other stages (p<0.05), but BCVA with HCL differed only between stage 1 and stage 4, with no differences between the other stages (p>0.05). There was no significant difference in the increase in BCVA with HCL according to KC stage (Kruskal-Wallis test, p=0.24). There was no difference between CL brands in terms of BCVA (Mann-Whitney U test, p=0.21).

Survey Results

Of the 68 patients, 8 (11.8%) stated that they could not afford to buy the prescribed CL and did not answer the questionnaire. Thirty-two patients answered the questionnaire completely. The overall reliability of the questionnaire was 87% (Cronbach's alpha: 0.872). The overall questionnaire score was 3.54 out of 5. Mean scores were 3.27 for overall satisfaction, 3.62 for visual satisfaction, 3.01 for satisfaction with lens insertion and removal, and 2.97 for satisfaction with lens comfort. Of the patients, 44.8% stated that they used the CL comfortably for more than 8 hours a day.

According to the survey results, itching and redness were the most common complaints. Mean visual quality scores were 3.25 for driving at night and 4.06 for driving during the day (difference between day and night, p=0.001). Most patients (83.9%) rated their visual quality in low light as moderate or better. There was no difference in visual quality between when the lens was first inserted and after wearing the lens for 6 hours (p=0.78). Visual quality with the HCL while working at a computer for long periods was scored as moderate or better by 81.8% of the patients. Previous CL use was reported by 29.1% of the patients, and 75% of this group had used CLs for more than 5 years. Of the patients with previous CL use, 63.6% reported using a rigid gas-permeable CL. Patients with and without previous CL use showed no significant difference in satisfaction in any category (p>0.05). KC was stage 1 in 12 (37.5%), stage 2 in 15 (46.9%), stage 3 in 4 (12.5%), and stage 4 in 1 (3.1%) of the patients who responded to the questionnaire, and there were no differences in satisfaction scores in any category according to KC stage (p>0.05).

Table 2. General demographic findings

Sex, n (%)	Female: 35 (51.5%), male: 33 (48.5%)
Side, n (%)	Right eye: 60 (54.5%), left eye: 50 (45.5%)
Age (years), mean ± SD	27.34±8
Corneal cross-linking therapy, n (%)	65 (59.1%)
Rigid corneal CL users, n (%)	14 (20.6%)
K1 (mm), mean ± SD	7.14±0.50
K2 (mm), mean ± SD	6.63±0.49
K_{mean} (mm), mean ± SD	6.89±0.48
Prescribed HCL base curve (mm), mean ± SD	6.84±0.50
BCVA with glasses, mean ± SD	0.36±0.2 (decimal Snellen) 0.53±0.32 LogMAR
BCVA with HCL, mean ± SD	0.80±0.14 (decimal Snellen) 0.10±0.09 LogMAR
Number of lens trials, mean ± SD	1.59±0.82 (median: 1, range: 1-4)
Prescribed HCL brands	Airflex: 70 (63.6%), EyeBrid: 40 (36.4%)

CL: Contact lens, BCVA: Best corrected visual acuity, HCL: Hybrid contact lens, SD: Standard deviation

Discussion

Among the special lens options for KC, HCLs are made using a gas-permeable rigid lens material in the center and a silicone or poly(2-hydroxyethyl methacrylate) (pHEMA) soft lens material around the edges, and are frequently preferred by physicians and patients in recent years because they combine the excellent optics of rigid lenses with the comfort of soft CLs.[8] Kloeck et al.[14] retrospectively evaluated 102 eyes of 54 KC patients fitted with HCL (SynergEyes, EyeBrid) and classified cone morphology in three categories as nipple, oval, and globus based on the axial curvature map and reported that VA was similar in all three morphological types and that VA increased from 0.63±0.29 with glasses to 0.93±0.14 with the HCL. The proportion of eyes that did not reach a VA of 0.8 with the HCL was 10.6% in eyes with oval cones, 4% in those with nipple cones, and 0% with globus cones. In their retrospective study including 45 patients

Table 3. Distribution of eyes by keratoconus stage					
	Stage 1	**Stage 2**	**Stage 3**	**Stage 4**	**p value**
Number of eyes	39 (35.5%)	56 (50.9%)	8 (7.3%)	7 (6.3%)	
Age (years), mean ± SD	25.32±6.7	29.00±8.5	27.50±5.8	25.25±11.9	0.345
BCVA with glasses, mean ± SD	0.45±0.18	0.33±0.19	0.24±0.16	0.22±0.14	0.002*
BCVA with HCL, mean ± SD	0.85±0.12	0.79±0.14	0.73±0.15	0.66±0.14	0.005**

BCVA: Best corrected visual acuity (decimal Snellen), HCL: Hybrid contact lens, SD: Standard deviation. *BCVA with glasses was statistically significantly higher in stage 1 compared to other stages ($p<0.05$), but there was no difference between the other stages. **BCVA with HCL was significantly higher only in stage 1 than in stage 4 ($p=0.008$), with no differences among the other stages ($p>0.05$).

Table 4. Comparison of patients' keratometry values according to the basic curve of the prescribed hybrid contact lens			
Topographic parameters	**Prescribed HCL flatter than K_{mean}, n=21**	**Prescribed HCL equal to K_{mean}, n=43**	**Prescribed HCL steeper than K_{mean}, n=46**
K1 (mm), mean ± SD	7.03±0.72	7.17±0.46	7.16±0.42
K2 (mm), mean ± SD	6.47±0.66	6.67±0.44	6.67±0.43
K_{mean} (mm), mean ± SD	6.75±0.69	6.93±0.44	6.92±0.41
Distribution of eyes according to KC stage, n (%)	Stage 1: 7 (33.3%) Stage 2: 9 (42.9%) Stage 4: 5 (23.8%)	Stage 1: 15 (34.9%) Stage 2: 24 (55.8%) Stage 3: 2 (4.7%) Stage 4: 2 (4.7%)	Stage 1: 17 (37%) Stage 2: 23 (50%) Stage 3: 6 (13%)

HCL: Hybrid contact lens, KC: Keratoconus, SD: Standard deviation

with advanced KC, Dikmetas et al.[11] reported that HCL were successfully fitted in 32 eyes (71.1%) of 32 patients and that BCVA increased from 0.5±0.2 LogMAR with glasses to 0.1±0.1 LogMAR with the HCL (EyeBrid, Airflex) ($p<0.001$). In the retrospective study by Uçakhan and Yeşiltaş[12] including 47 eyes of 33 patients who were prescribed EyeBrid and Airflex HCLs, uncorrected VA was 0.97±0.55 logMAR, BCVA with glasses was 0.32±0.31 logMAR, and BCVA with HCL was 0.05±0.09 logMAR ($p<0.001$). In another retrospective study involving 34 eyes of 25 patients prescribed EyeBrid and Airflex HCLs, Harbiyeli et al.[16] reported that VA increased from 0.76±0.41 logMAR with glasses to 0.14±0.15 logMAR with the HCL ($p<0.01$). In our study, the patients' mean spectacle-corrected VA increased from 0.36±0.2 (0.53±0.32 LogMAR) to 0.80±0.14 (0.10±0.09 LogMAR) with the HCL (Wilcoxon test, $p<0.0001$).

In addition to visual rehabilitation, the use of CLs in KC patients aims to increase patients' quality of life, especially in the advanced stages, by reducing dependence on glasses with high spherical and cylindrical power. It is essential that an HCL provides good VA and is comfortable. In their retrospective study including 79 eyes of 54 patients fitted with HCLs, Nau[17] compared comfort with the SynergEyes HCL and rigid gas-permeable CLs and reported that 79.5% of the patients reported greater comfort with the HCLs. In the retrospective study by Harbiyeli et al.,[16] which included 25 patients with a mean age of 29±13 years, the 18 patients who responded to the satisfaction survey had a mean subjective assessment score of 3.3/5, visual quality score of 4/5, and lens acclimation score of 2.8/5. In our survey, the overall score was 3.54/5, the mean visual satisfaction score was 3.62/5, the general satisfaction score was 3.27/5, the satisfaction score for lens insertion and removal was 3.01/5, and the satisfaction score for lens comfort was 2.97/5. The absence of a significant difference between VA scores for the lenses when first inserted and 6 hours after insertion indicates that the HCLs provide the same quality of vision throughout the day.

In KC-specific lens applications, several lens trials are performed until an appropriate CL is found. This is a time-consuming process for both the patient and physician. Selecting the base curve of the first trial CL according to the patient's keratometric values reduces the number of trial lenses and the duration of the examination. In their retrospective study, Uçakhan and Yeşiltaş[12] fit EyeBrid and Airflex lenses to 37 eyes with KC (stage 1: 13 eyes, stage 2: 19 eyes, stage 3: 3 eyes, stage 4: 2 eyes), 4 eyes with corneal scar after keratitis, 2 eyes with corneal scar after trauma, 2 eyes with ectasia after refractive surgery, 1 eye with ectasia after corneal transplantation, and 1 eye with corneal scar due to hydrops (47 eyes in total). Rigid gas-permeable CLs were tried by these patients before HCL fitting but they either were not tolerated by the patients or could not be seated on the cornea. The mean number of trial lenses was found to be 1.4±0.6 (range: 1-3), with an appropriate HCL prescribed after the first trial in 32 eyes (68.1%) and after the second trial in 12 eyes (25.5%). The mean base curve of the prescribed HCLs was 7.3±0.4 mm, with HCL base curves flatter than K_{mean} in 68.1%, equal to the K_{mean} in 10.6%, and steeper than K_{mean} in 21.3% of the eyes.[12] Harbiyeli et al.[16] prescribed EyeBrid and Airflex for 34 eyes of 25 patients and reported the mean number of lens trials as 1.4. Nau[17] prescribed the SynergEyes HCL to 79 eyes of 54 patients with irregular astigmatism and reported a mean of 1.71 trial lenses (range: 1-4). In our study, the mean

number of lens trials was 1.59±0.82 (range: 1-4). The base curve of the prescribed HCL was equal to K_{mean} in 39.1%, steeper in 41.8%, and flatter in 19.1% of the eyes in our study. Although there was no statistically significant difference between these three groups in terms of topographic keratometry values, when the groups were examined in detail, we determined that HCLs with base curves equal to or steeper than the K_{mean} were prescribed to early-stage KC patients, while HCLs with base curves flatter than the K_{mean} were prescribed to advanced-stage KC patients.

The literature data indicate that the three main reasons for discontinuing HCL use are that the lens is uncomfortable, expensive, and difficult to insert and/or remove. Uçakhan and Yeşiltaş[12] reported that 4 patients (7 eyes, 14.8%) in their study never purchased the prescribed CL. Three of the patients did not buy the CL because it was costly, and one patient did not buy the CL because they thought they would not be able to use it. In the same study, 27.5% of the patients stopped using the CL for reasons such as discomfort (5 eyes, 10.6%), difficulty with insertion/removal (4 eyes, 8.5%), and high cost (2 eyes, 4.2%). Kloeck et al.[14] prescribed EyeBrid and SynergEyes HCLs for 102 eyes of 54 patients diagnosed with KC and reported that the lens was successfully used in 52 eyes (51%) at 6-month follow-up. Patients unable to use the lens cited discomfort (73%), difficulty with insertion and removal (37.8%), and inadequate vision level (2.7%) as the reasons. Abou Samra et al.[15] prescribed spherical HCL (Duette lens SynergEyes, Inc., Carlsbad, CA, USA) to 18 eyes of 18 patients with high regular astigmatism and reported that 11.1% of these patients stopped using the HCL because the lens was not comfortable, 11.1% because it was expensive, and 5.6% because it was difficult to insert/remove. Similarly, the categories with the lowest scores in our satisfaction survey were lens insertion and removal (mean satisfaction score 3.01/5) and lens comfort (mean satisfaction score 2.97/5). The cost of HCLs is a significant disadvantage for patients, and 11.8% (n=8) of the patients in this study stated that they could not afford to buy the lens. Piggyback CLs, which consist of a rigid gas-permeable CL placed over a soft CL, are cheaper, comfortable, and have diverse options, and may be considered as an alternative in patients with failed fitting or intolerance of rigid gas-permeable CLs.

Study Limitations

Limitations of our study were that the eyes in the sample were mostly KC stage 1 and 2, the proportion of corneal rigid gas-permeable CL users was low (20%), and we could not perform a comparative study with different CL options.

Conclusion

This study showed that in eyes with different stages of KC and steepest keratometry values ranging from 5.07 to 7.84 mm, an appropriate HCL could be determined in the first two trials in 85% of cases, these lenses increased the mean BCVA from 0.36±0.2 (0.53±0.32 LogMAR) with glasses to 0.80±0.14 (0.10±0.09 LogMAR), and CL satisfaction scores were moderate to good (≥3 out of 5) in all categories. The base curve values of the prescribed HCLs were found to be very close to the topographic K_{mean} value. Therefore, the average of K1 and K2 values or a steep value of 0.1 mm can be recommended when determining HCL curves in the first trial. Disadvantages of HCLs are that they are not as comfortable as soft CLs, insertion/removal can be difficult, and the lenses have a short life and high cost compared to rigid gas-permeable CLs. With the production of longer-lasting and lower-cost lenses in the future, HCLs will be more preferred by ophthalmologists and patients because of their ease of fitting and use.

Ethics

Ethics Committee Approval: Selçuk University Faculty of Medicine Dean's Office Local Ethics Committee (decision no: 2020/13, date: 20.12.2019).

Informed Consent: Obtained.

Peer-review: Externally peer reviewed.

Authorship Contributions

Concept: A.S., B.B., Y.K., S.O., Design: A.S., B.B., Y.K., S.O., Data Collection or Processing: A.S., B.B., Y.K., S.O., Analysis or Interpretation: A.S., B.B., Y.K., Literature Search: A.S., B.B., Writing: A.S., B.B., Y.K., S.O.

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References

1. Vazirani J, Basu S. Keratoconus: current perspectives. Clin Ophthalmol. 2013;7:2019-2030.
2. Romero-Jiménez M, Santodomingo-Rubido J, Wolffsohn JS. Keratoconus: a review. Cont Lens Anterior Eye. 2010;33:157-166.
3. Wollensak G. Crosslinking treatment of progressive keratoconus: new hope. Curr Opin Ophthalmol. 2006;17:356-360.
4. Gomes JA, Tan D, Rapuano CJ, Belin MW, Ambrósio Jr R, Guell JL, Malecaze F, Nishida K, Sangwan VS. Global consensus on keratoconus and ectatic diseases. Cornea. 2015;34:359-369.
5. Korb D, Finnemore V, Herman J. Apical changes and scarring in keratoconus as related to contact lens fitting techniques. J Am Optom Assoc. 1982;53:199-205.
6. Zadnik K, Barr JT, Steger-May K, Edrington TB, McMahon TT, Gordon MO. Comparison of flat and steep rigid contact lens fitting methods in keratoconus. Optom Vis Sci. 2005;82:1014-1021.
7. Carracedo G, Martin-Gil A, Peixoto-de-Matos SC, Abejón-Gil P, Macedo-de-Araújo R, González-Méijome JM. Symptoms and signs in rigid gas permeable lens wearers during adaptation period. Eye Contact Lens. 2016;42:108-114.
8. Şengör T, Kurna SA. Update on contact lens treatment of keratoconus. Turk J Ophthalmol. 2020;50:234-244.
9. Downie LE, Lindsay RG. Contact lens management of keratoconus. Clin Exp Optom. 2015;98:299-311.
10. Rico-Del-Viejo L, Garcia-Montero M, Hernàndez-Verdejo JL, García-Làzaro S, Gómez-Sanz FJ, Lorente-Velàzquez A. Nonsurgical procedures for keratoconus management. J Ophthalmol. 2017;2017:9707650.
11. Dikmetas O, Kocabeyoglu S, Mocan MC. Evaluation of visual acuity outcomes and corneal alterations of new generation hybrid contact lenses in patients with advanced keratoconus. Cornea. 2020;39:1366-1370.

12. Uçakhan ÖÖ, Yeşiltaş YS. Correction of irregular astigmatism with new-generation hybrid contact lenses. Eye Contact Lens. 2020;46:91-98.
13. Gantz L, Gordon-Shaag A, Gideon-Abousaid A, Serero G, Fine P. Keratoconic Bi-aspheric Contact Lenses. Int J Kerat Ect Cor Dis. 2016;5:132-138.
14. Kloeck D, Koppen C, Kreps EO. Clinical Outcome of Hybrid Contact Lenses in Keratoconus. Eye Contact Lens. 2021;47:283-287.
15. Abou Samra WA, El-Emam DS, Kasem MA. Clinical performance of a spherical hybrid lens design in high regular astigmatism. Eye Contact Lens. 2018;44 Suppl 1:S66-S70.
16. Harbiyeli II, Erdem E, Isik P, Yagmur M, Ersoz R. Use of new-generation hybrid contact lenses for managing challenging corneas. Eur J Ophthalmol. 2021;31:1802-1808.
17. Nau AC. A comparison of synergeyes versus traditional rigid gas permeable lens designs for patients with irregular corneas. Eye Contact Lens. 2008;34:198-200.

Appendix 1. Contact lens survey				
1) How long have you been using hybrid contact lenses?	≤6 months	6 months-1 year	1-2 years	>2 years
2) What brand of hybrid contact lenses do you use?	EyeBrid	Airflex	Ultrahealth	Other
3) Have you used contact lenses before?	Yes	No		
4) If you answered yes, how many years did you used them?	≤1 year	1-2 years	2-5 years	>5 years
5) Please specify the lens you used before.	Soft lenses		Rigid gas-permeable lens	
6) How many hours a day do you wear contact lenses on average?	<4 hours	4-8 hours	8-10 hours	>10 hours
Please rate your answers to the following questions from 1 to 5.				
7) How would you rate the overall comfort of the lenses?				
1 (Not comfortable at all)	2	3	4	5 (Very comfortable)
8) How would you rate the comfort of lens during all-day wear (after at least 6 hours)?				
1 (Not comfortable at all)	2	3	4	5 (Very comfortable)
9) Do you feel itching while wearing the lens?				
1 (Never had itching)	2	3	4	5 (Severe itching)
10) Have you felt pain while wearing the lens?				
1 (Never had pain)	2	3	4	5 (Severe pain)
11) Do you have eye redness while wearing the lens?				
1 (Never had redness)	2	3	4	5 (Severe redness)
12) Is inserting the lens difficult for you?				
1 (Very easy)	2	3	4	5 (Very difficult)
13) Is removing the lens difficult for you?				
1 (Very easy)	2	3	4	5 (Very difficult)
14) How would you rate your vision quality with the lens when working at a computer for a long time?				
1 (Very poor)	2	3	4	5 (Very good)
15) How is your vision quality when driving at night?				
1 (Very poor)	2	3	4	5 (Very good)
16) How is your vision quality when driving during the day?				
1 (Very poor)	2	3	4	5 (Very good)
17) How would you rate your visual acuity when you first insert the lens?				
1 (Low quality)	2	3	4	5 (High quality)
18) How would you rate your visual acuity after six hours of wearing the lens?				
1 (Low quality)	2	3	4	5 (High quality)
19) How is your vision quality in low light?				
1 (Very poor)	2	3	4	5 (Very good)
20) Did the lens you use meet your expectations?				
1 (Not at all)	2	3	4	5 (Completely)
21) Has the lens you use improved your quality of life?				
1 (Not at all)	2	3	4	5 (Very much)
22) Has using the lens increased your morale?				
1 (Not at all)	2	3	4	5 (Very much)
Items 7-11. Questions evaluating lens comfort Items 12-13. Questions evaluating the difficulty of insertion and removal Items 14-19. Questions evaluating vision quality Items 20-22. Questions evaluating overall satisfaction				