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Case report

Corneo-scleral contact lenses in an uncommon case of keratoconus with high hyperopia and astigmatism

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ABSTRACT

Purpose: To analyse the visual quality achieved by fitting corneo-scleral contact lenses (CScL) in an uncommon case of bilateral keratoconus, high hyperopia and astigmatism.
Methods: A 45-year-old man presented for eye examination due to the unsatisfactory quality of his vision wearing soft toric contact lenses. He presented high hyperopia and astigmatism with bilateral keratoconus. He was fitted with CScL to correct his irregular astigmatism and ocular aberrations. A diagnostic trial set was used in the fitting process and he was assessed according to standardised fitting methodology. Visual acuity, corneal topography, biometry and ocular aberrations were evaluated. The follow-up period was 1 year.
Results: The best spectacle-corrected visual acuity was 20/32 with $+8.00/-4.50 \times 30^{\circ}$ for the right eye (RE) and 20/25 with $+7.75/-2.25 \times 120^{\circ}$ for the left eye (LE). After CScL fitting, visual acuity was improved to 20/20 and 20/16 for the RE and LE, respectively. The patient wore these contact lenses an average of 13 h a day. The total high order aberrations decreased by approximately 79% in the RE (2.37–0.50 μm) and 47% in the LE (1.04–0.55 μm) after CScL fitting. Visual quality and wearing time were maintained after 1 year wearing CScL. In addition, no adverse ocular effects were found during this period.
Conclusion: The present case report describes how the patient had CScL fitted successfully for management of keratoconus with high hyperopia and astigmatism. They provided optimal visual quality, along with prolonged use times and no adverse effects to the cornea.

1. Introduction

Keratoconus is typically a bilateral asymmetric, progressive and non-inflammatory thinning disorder of the cornea that affects both genders and all ethnicities. It usually appears during the second decade of life and it commonly progresses until the fourth decade of life when it tends towards stabilization [1–4]. The actual incidence in the general population is not clear, as it depends on the geographic location, diagnosis criteria used and the cohort of patients selected (large studies estimate between 50 and 230 per 100,000) [5–9].

The ocular symptoms vary depending on disease severity. Patients with disease progression present decreased vision affecting their visual quality due to high myopia and irregular astigmatism, along with the high order ocular aberrations (HOAs) that are manifested [1]. Therefore, loss of visual quality cannot be compensated with spectacles [10].

Signs of keratoconus are also presented in relation to severity of disease. Corneal topography is commonly a gold standard for detecting and managing keratoconus [11]. At incipient stages (subclinical, formes fustres), keratometry readings can commonly be within the normal range, but may appear irregular. In addition, the cornea may appear normal on slit-lamp biomicroscopy. However, in moderate-to-severe cases, slit-lamp biomicroscopic findings, such as Vogt's striae, Fleischer's ring and corneal scarring are presented [1]. Munson's sign and hydrops are observed, especially when keratoconus is in advanced stages [1,12].

Keratoconus management in mild-to-moderate cases is mainly accomplished with corneal rigid gas-permeable (RGP) contact lenses because of high levels of irregular astigmatism [13]. In these cases, corneal RGP contact lenses provide an effective option by masking corneal-surface irregularities with the tear lens between the posterior contact lens surface and anterior corneal surface [14]. When these contact lenses are not well tolerated (excessive movement and/or decentred lens), due to the irregularity of the cornea, then corneo-scleral or scleral contact lenses may be an appropriate option. These contact lenses offer

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several advantages (due to their large diameter in relation to corneal RGP lenses), such as excellent comfort, centration and stability [15], which may also provide an improvement in the quality of vision [16,17].

Keratoconus is commonly presented with irregular astigmatism and myopia although it can also include hyperopia. However, keratoconus is not common with high hyperopia and astigmatism [18]. Therefore, due to the specific ocular characteristics of the highly hyperopic eye, fitting corneo-scleral contact lenses (CScL) can be a challenging case. Also, it should be noted that these lenses may present specific characteristics due to positive high power, which could affect the ocular physiology and the fitting procedure. In addition, it was not known to what extent these lenses would provide an improvement in the visual quality in this specific case.

We present an uncommon case of fitting CScL for keratoconus management with high hyperopia and astigmatism in terms of visual quality.

2. Case report

A 45-year-old man presented for eye examination due to unsatisfactory visual quality with his soft toric contact lenses. He consented to the use of his clinical data for research purposes. This case was conducted in accordance with the tenets of the Declaration of Helsinki and it complies with the ethical requirements set by the University of Valencia.

The eye examination was performed at the FISABIO Oftalmología Médica Clinic. This included refraction, anterior eye biomicroscopy, ocular fundus examination, corneal topographic analysis using the Pentacam HR Eye Scanner (Oculus Inc., Wetzlar, Germany) and ocular biometry with the IOLMaster (Carl Zeiss Meditec AG, Jena, Germany).

In addition, the ocular aberrations were measured with the Alcon LADARWave (Custom Cornea Wavefront System, Alcon Laboratories Inc, Ft Worth, Texas, USA) on a pupil size of 6 mm with pharmacological intervention for mydriasis (1% tropicamide eye drops). The aberrometer system uses three of five individual measurements to determine the optimal finding. Aberrometry data include traditional spherocylindrical refractive error, spherical equivalent, percentage of defocus and astigmatism participation in all ocular aberrations, and the root mean square (in terms of micrometres of deviation, μm) of defocus, astigmatism, coma aberration, spherical aberration and other HOAs. The measurements were performed before and after fitting the contact lenses and at 1 year of follow-up. In these sessions, these devices were previously calibrated and the measurements were performed by professionals who were expert in handling them.

Table 1 shows the clinical outcomes from the patient. The exam determined a diagnosis of high hyperopia and astigmatism with bilateral asymmetric keratoconus (Figs. 1 and 2). Slit-lamp biomicroscopic findings determined a corneal thinning over the apex of cone and a Fleischer ring around its base in the right eye (RE). With regard to the left eye (LE), no signs of keratoconus were manifested.

Table 1
Clinical outcomes of the patient.

Parameter	Right eye	Left eye
Refraction (dioptres)	+8/−4.5 × 30°	+7.75/−2.25 × 120°
Best Spectacle-Corrected Visual Acuity	20/32	20/25
Anterior Corneal Elevations (μm)	53	32
Posterior Corneal Elevations (μm)	70	53
Simulated Keratometry (dioptres)	42.60/49.40 × 33°	41.20/45.00 × 128°
Corneal Astigmatism (dioptres)	6.80	3.80
Thinnest Corneal point (μm)	444	486
Anterior chamber depth (mm)	3.26	3.06
Axial length (mm)	21.03	21.50

Following the eye examination, CScL were fitted in this case (Scleracon, Lenticon, Madrid, Spain). These contact lenses are made of fluoro-silicone acrylate (Optimum extreme; Contamac Ltd, Saffron Walden, UK) which is a highly gas-permeable material. Its oxygen permeability (ISO) is 125×10^{-11} (cm^2/s) (mlO2)/(ml × mmHg). As described by the manufacturer, the design is multi-aspherical with three curves, the base curve, intermediate curve and peripheral curve (or scleral curve). A plasma treatment is recommended for these contact lenses. The average central thickness of this lens is 0.27 mm. Table 2 shows the CScL fitting parameters. All contact lenses were fitted by means of the trial-lens method and the subject was assessed according to a standardised fitting methodology. Three visits were needed to fit this contact lens.

At the first visit, the fitting parameters were determined in order to manufacture the lenses. The trial-lens set consisted of 30 lenses with a specific back optic zone radius and peripheral curve. Two steps were needed to fit this contact lens. Firstly, the base curve, which was initially selected flatter (0.20 mm) than the average simulated central keratometry readings (Km) by corneal topography (Km = 7.35 mm for the RE and Km = 7.85 mm for the LE) in accordance with the manufacturer's suggestions. These first trial lenses were not appropriate and several flatter trial lenses were tested until the fluorescein pattern presented a slight alignment to minimal apical corneal clearance between the posterior surface of the lens and the anterior surface of the central cornea (0.60 mm and 0.35 mm flatter than the Km for the RE and LE, respectively). The goal with these lenses was to find the minimal sagittal height that vaults the cornea [19]. It should be noted that some form of "feather touch" on the apex of the cornea could be permitted since these lenses do not usually move enough to irritate the apex of the cone and therefore they are well tolerated. In some cases, although the lens appears to show a strong corneal support, this does not necessarily mean there is actually "touch", fluorescein layers may be present with a thickness shy of roughly 20 μm, and the human eye is not capable of seeing [19]. No degree of apex staining was permitted. Following the same procedure, other lenses from the same set were tried until the fluorescein pattern determined the appropriate peripheral curve, which should present an adequate tear exchange with no compression of the limbus and conjunctiva. In this case, the parameters of base curve, diameter and power were 7.95 mm, 13 mm, +9.50 D and 8.20 mm, 13 mm, +9.00 D for the RE and LE, respectively (Figs. 3 and 4). In addition, to avoid excessive weight and thickness of the lens, the manufacturer suggested a lenticular design, which is not common in this type of contact lenses.

During the second visit, the manufactured lenses were inserted and these were allowed to settle on the eye for 30 min. Slit-lamp biomicroscopy findings determined optimal values for lens position and lens movement with no compression of the limbus and conjunctiva. Then, visual acuity and ocular aberrations were measured. Visual acuity was significantly improved to 20/20 for the RE and 20/16 for the LE. More importantly, a significant improvement in ocular aberrations was found. Table 3 shows the ocular aberrations before and after fitting the CScL. The total HOAs decreased by approximately 79% in the RE and 49% in the LE. Finally, the patient was instructed in lens care and handling and was advised to increase lens-wear time by 1 h each day for 7 days.

At the third visit, after 8 h of CScL wear, the fit was checked again. Slit-lamp biomicroscopy findings determined optimal values for the lens position and lens movement and no adverse ocular effects, such as corneal and/or limbal staining, were found. Follow-up was performed at 1, 6 and 12 months.

After 1 year wearing CScL optimal values for the lens position and lens movement were maintained and no adverse ocular effects were presented. In addition, no significant differences were found in ocular aberrations and visual acuity with respect to the initial fitting.