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Adaptation of scleral contact lenses in a patient with steroid-induced glaucoma treated with Ahmed valve: A case report

Adaptación de lentes de contacto de apoyo escleral en paciente con glaucoma esteroideo tratado con válvula de Ahmed: reporte de caso

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ABSTRACT
Patients with advanced keratoconus are frequently managed with surgical procedures such as penetrating keratoplasty. This, in turn, requires postoperative pharmacological management that includes steroids and immunomodulators that must be controlled continuously to avoid secondary complications such as steroid-induced glaucoma. In the present case, an adaptation of scleral contact lenses is described in a patient with steroid-induced glaucoma treated with Ahmed valve, to report management and the most relevant clinical considerations.

Keywords: secondary glaucoma, Ahmed valve, keratoplasty, scleral contact lens.

RESUMEN
Los pacientes con queratocono avanzado frecuentemente terminan siendo manejados con procedimientos quirúrgicos como la queratoplastia penetrante. Esta, a su vez, requiere un manejo farmacológico posquirúrgico que incluye esteroides e inmunomoduladores que deben ser controlados de forma continua para evitar complicaciones secundarias como el glaucoma esteroideo. En el presente caso se expone una adaptación de lentes de contacto de apoyo escleral en paciente con glaucoma esteroideo tratado con válvula de Ahmed. Se reportan el manejo y las consideraciones clínicas más relevantes.

Palabras clave: glaucoma secundario, lente de contacto escleral, queratoplastia, válvula de Ahmed.

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INTRODUCTION

For the treatment of keratoconus, penetrating keratoplasty is one of the most frequently used alternatives in patients with high degree of corneal irregularity and thinning. It is important to note that during the last fifty years, penetrating keratoplasty has gone from being considered as a "high-risk procedure" to a surgical intervention of great importance and optimal results (1).

This procedure is a surgical option in the treatment of severe and complicated corneal ectasias, with the appearance of stretch marks, membrane rupture, and hydrops. It consists of the replacement of diseased corneal tissue, which can have a variable diameter and a total thickness corresponding to the receptor; double continuous suture or single stitches are used (2). The purpose of this type of intervention is to replace the opaque tissue with a transparent one that optically allows for a clearer and more uniform refraction. This type of interventions requires a careful postoperative management of inflammations and suppression of the immune system, which allows adequate graft health in the receptor, and avoids its rejection by the major histocompatibility complex (MHC) (3).

Postoperative ocular pharmacotherapy for this type of transplants has been topically administered corticosteroids, in addition to prophylactic antibiotic management (4). One of the most frequent indications is managing corneal graft rejection, also called corneal transplant rejection syndrome, which usually occurs prematurely or late in 10 to 65% of transplants, depending on the type of the host. Given that drop penetration into the stroma can only be 1.5 to 3% when applied in the form of ophthalmic solution (5), in order for the corticoid to act, in these cases it is essential to apply (frequent) doses, which increases the risk of producing cataract or secondary glaucoma (6).

The case presented below shows considerations and complications that happened after a surgical intervention with penetrating keratoplasty, its subsequent pharmacological treatment with high potency and medium penetration corticosteroids (7), which caused a secondary steroid glaucoma with a decrease in trabecular flow, due to the pharmacological interaction between corticosteroids and prostaglandins, which have an important structural role in the trabeculum (7). These factors led to the implantation of an Ahmed valve, an artificial device that improves the flow of aqueous humor into the conjunctival space through a silicone tube attached to a polypropylene plate, which aimed to avoid further damage to internal ocular structures, including the head of the optic nerve.

OBJECTIVE

To report on scleral contact lens fitting in a case of steroid glaucoma and keratoconus, treated with Ahmed valve and bilateral penetrating keratoplasty.

METHODOLOGY

A clinical case with the following characteristics was evaluated: Ahmed valve due to steroid- induced glaucoma, pseudophakia due to steroid cataract corrected with IOL (intraocular lenses), and irregular cornea related to bilateral penetrating keratoplasty, according to clinical history data (anamnesis, visual acuity measured on the Snellen scale, ophthalmoscopy, biomicroscopy). The selection and adaptation of contact lenses were based on the manufacturer's corresponding instructions. The adaptation was considered optimal, since it reached maximum visual acuity on the Snellen scale. The integrity of eye structures was respected. The present study counts with the patient's informed consent.

Visual information collection method

Photographs were taken in the doctor's office, using a Canon T3i Reflex and T5 camera with lenses of 100 and 75 mm, as well as a Vanguard Series 70 tripod (8). A slit lamp was used with different illuminations (diffuse, parallelepiped,

scleral dispersion, cobalt blue, and yellow filter), as well as various close-up lenses. Saline solution 0.9% was also used and two coloring agents (traditional fluorescein and lissamine green staining) in order to assess fitting and ocular surface.

CLINICAL CASE

The patient is a 30-year-old female, active in work, who was referred to the corneal service for the adaptation of special contact lenses. As antecedents previous to the fitting process, the patient presented with keratoconus 13 years before, which was treated with a conventional piggyback fitting (a permeable gas rigid lens on a silicone hydrogel soft lens). Around 2013, the corneal ophthalmologist made the decision to perform a cornea transplant in the right eye due to the advancement of keratoconus and corneal thinning, but five months after the procedure the transplant showed a corneal abscess. The abscess was treated with moxifloxacin and prednisolone, the latter with a dose every two hours for a month. After the month ended, the patient attended control with a cornea specialist, who found a posterior subcapsular opacity on the crystalline lens and an intraocular pressure (IOP) of 73 mmHg in the right eye. In addition, the posterior pole had an excavation of 0.7 with pale papilla. The diagnosis given by the cornea specialist was chronic uveitis, steroid glaucoma, and steroid cataract. The specialist suspended the application of prednisolone, and changed it to fluorometholone 0.1% every eight hours. In addition, he prescribed timolol 0.5% every 12 hours, Isopto Atropine 1% every 12 h in the right eye, and priority remission to a glaucoma specialist.

In the appointment, the glaucoma specialist found an optic nerve with excavation of 0.9, diffuse thinning, and beta atrophy. He did not report hemorrhage in the macula, but he did observe generalized atrophy of the RPE, all this in the right eye. In the left eye, an optic nerve with excavation of 0.7 was observed, with superior-temporal and inferior-temporal thinning, beta atrophy, and healthy macula. Because of uncontrolled IOP by steroidal glaucoma in both eyes, the glaucoma specialist prescribed timolol, brimonidine, and oral acetazolamide, and, as supportive tests, he ordered 10-2 visual fields and optical coherence tomography (OCT) on the optic nerve. Likewise, he ordered fluorometholone 0.1% and atropine in the right eye (RE) and proposed urgent glaucoma surgery with implants, as well as scleroplasty under general anesthesia due to advanced damage in the right eye.

The procedure was carried out a month later, in which an Ahmed FP-7 implant was placed and scleroplasty was performed. Two days after surgery, the patient reported decreased eye pain and said she felt well, although her vision was reduced. She was checked again by the cornea specialist, who ordered Pentacam examinations to evaluate the progression of keratoconus in the left eye. Subsequently, the patient was remitted again to the glaucoma specialist to review the exam results, and he found an island at five temporal degrees that affected the visual axis. Steroid cataract was also observed in the presence of right eye keratoplasty due to bilateral keratoconus, with terminal damage in RE without IOP control with maximum medication. The glaucoma specialist proposed filtering bleb and valvular tube revision. Two days after assessment by glaucoma specialist, the patient returned to control with the cornea specialist, who reviewed the Pentacam exams, which showed a keratometry of 57:25/59.8×81 for the left eye; in addition, a minimum thickness of 238 µ was observed, which evidenced a grade 4 ectasia. Because of these characteristics, the ophthalmologist-cornea specialist considered that the patient required penetrating keratoplasty in the LE. He also recommended phacoemulsification due to steroid cataract, for which a biometry was ordered to calculate intraocular lens power.

Three days later, the specialist proceeded to perform cataract surgery, and implanted an intraocular lens with phacoemulsification technique. In addition, he reviewed the filtering bleb and performed an anterior examination of the Ahmed

valve. Five months after the cataract surgery, the patient returned to appointment with cornea specialist, who recommended penetrating keratoplasty in the left eye.

In 2016, penetrating keratoplasty was performed in the LE due to grade 4 keratoconus. Controls started on the next day, and followed at a week, two weeks, and a month; they showed a stable and uncomplicated cornea. In 2017, the ophthalmologist-glaucoma specialist performed a glaucoma surgery in the patient's left eye to implant an Ahmed valve, as well as scleroplasty. After several postoperative months, a stable cornea was found without opacity, as well as stable IOP, so the patient was referred to an optometrist-contact lens specialist for assessment and possible alternatives for contact lens fitting.

Visual acuity SC: RE: 20/70 LE: 20/200.

Biomicroscopy: RE: pseudophakic; clear corneal button; calm and without obvious alterations; bleb over undisturbed valve; tube without obstruction; not showing fluorescein or lissamine green stain; intraocular lens in position and without opacity (Figure 1).

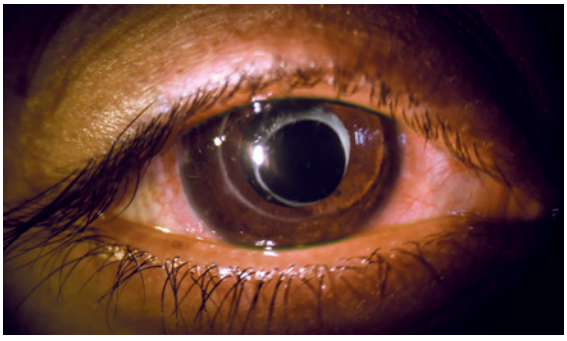


FIGURE 1. ***Biomicroscopy*** **RE: Corneal button in position and without obvious alterations; IOL in position and without opacity**

Source: Author's elaboration.

LE: Clear corneal button; calm and without obvious alterations; bleb over undisturbed valve; tube without obstruction; no sign of fluorescein or lissamine green stain; cornea with transparent graft (Figure 2).

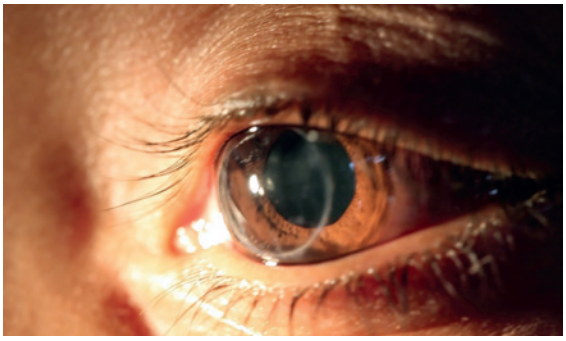


FIGURE 2. ***Biomicroscopy*** **LE: Corneal button in position and without obvious alterations, ocular annexes without alterations**

Source: Author's elaboration.

Ophthalmoscopy: RE: Macular and foveolar area without evident alterations; artery-vein ratio 2/3; pupil with defined edges; excavation 0.8.

LE: Macular and foveolar area without evident alterations; artery-vein ratio 2/3; pupil with defined edges; excavation 0.7.

Refraction:
RE: +3.75 –0.50 × 60 (scissor shadows, tentative formula) AV: 20/40
LE: –6.00 –7.50 × 165 (scissor shadows, tentative formula) AV: 20/50

Contact lens fitting parameters

After discussing with patient existing treatment options, a scleral contact lens fitting was decided. Ocular condition, scleral profile, and corneal shape were determined. For the latter, the patient's Pentacam and Scheimpflug images were used (figures 3 and 4). The parameters obtained with Pentacam were used to select the initial test lens (Table 1). Lenses were inserted and removed according to the specifications given by the manufacturer; saline solution 0.9% was used in a single-dose presentation, free of preservatives and fluorescein for testing (9-12).

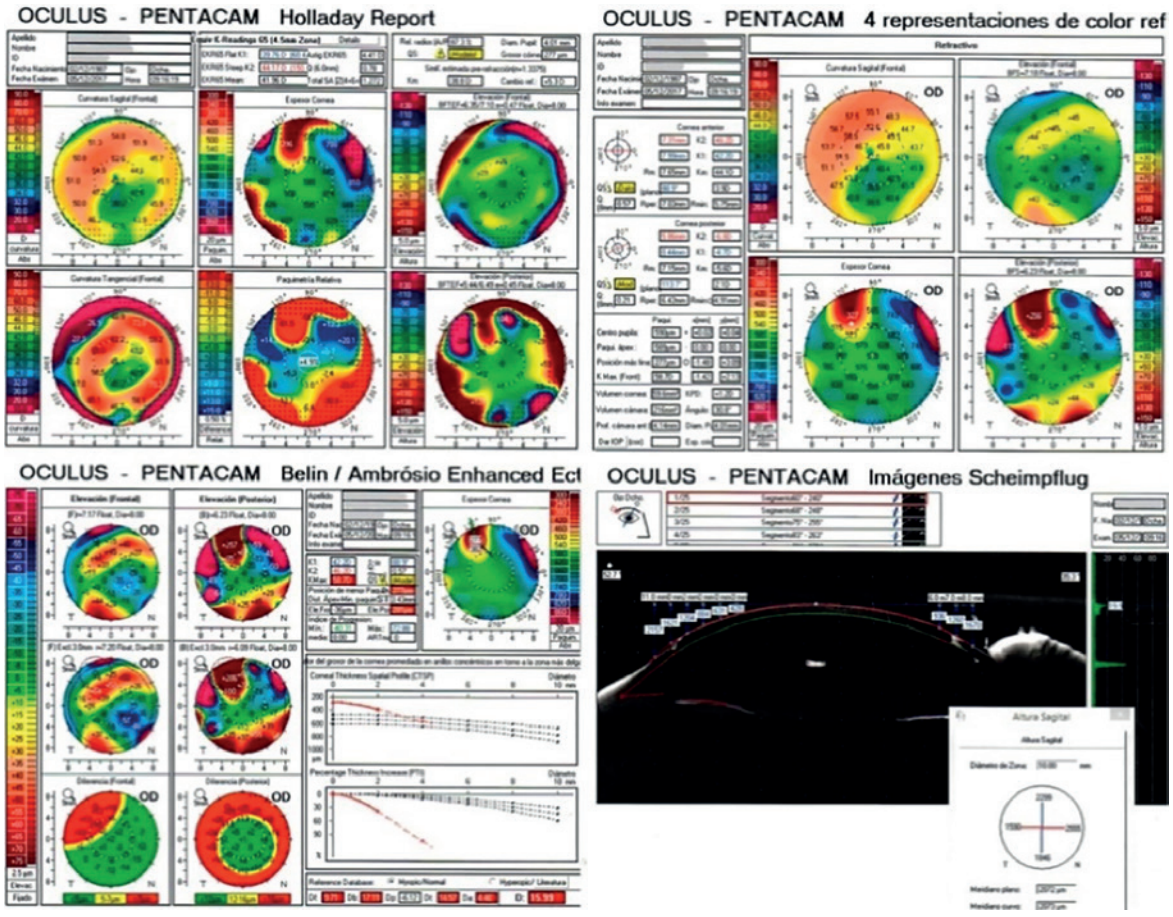


FIGURE 3. **Pentacam RE: A set of elevation maps, refractive maps, Belin/Ambrósio, and Scheimpflug images**

Source: Author's elaboration.

TABLE 1. **Parameters of test contact lenses**

RE		LE	
CB	5.80	CB	6.00
Power	–12.00	Power	–11.00
Sagitta	5.481	Sagitta	5.258
Diameter	15.60	Diameter	15.60
Material	Optimum extra	Material	Optimum extra
DK	100	DK	100

Three aspects were evaluated after the lenses were placed:

- Clearance (between 100 to 300 µ).
- Limbus-transition zone (between 50 to 80 µ).
- Scleral zone (uniform landing and at right angle to the sclera) (9-12).

Over-refraction found in RE was –2.50–4.50 × 20, and in LE, –15.50 without distance to vertex, with which the patient achieved far visual acuity of 20/30 in RE and 20/30 in LE (on the Snellen scale), and a close vision of 0.75 m. Scleral lenses were left for 4 h, then patient returned to the doctor's office to re-evaluate lens functioning using a biomicroscope (Figure 5).

Test lenses showed several fitting complications (Table 2), so different changes were made to the final lenses for a customized fitting, seeking as a first measure to avoid blanching, sealed lenses, and compression on the Ahmed valve, as well as to decrease clearance where a space larger than

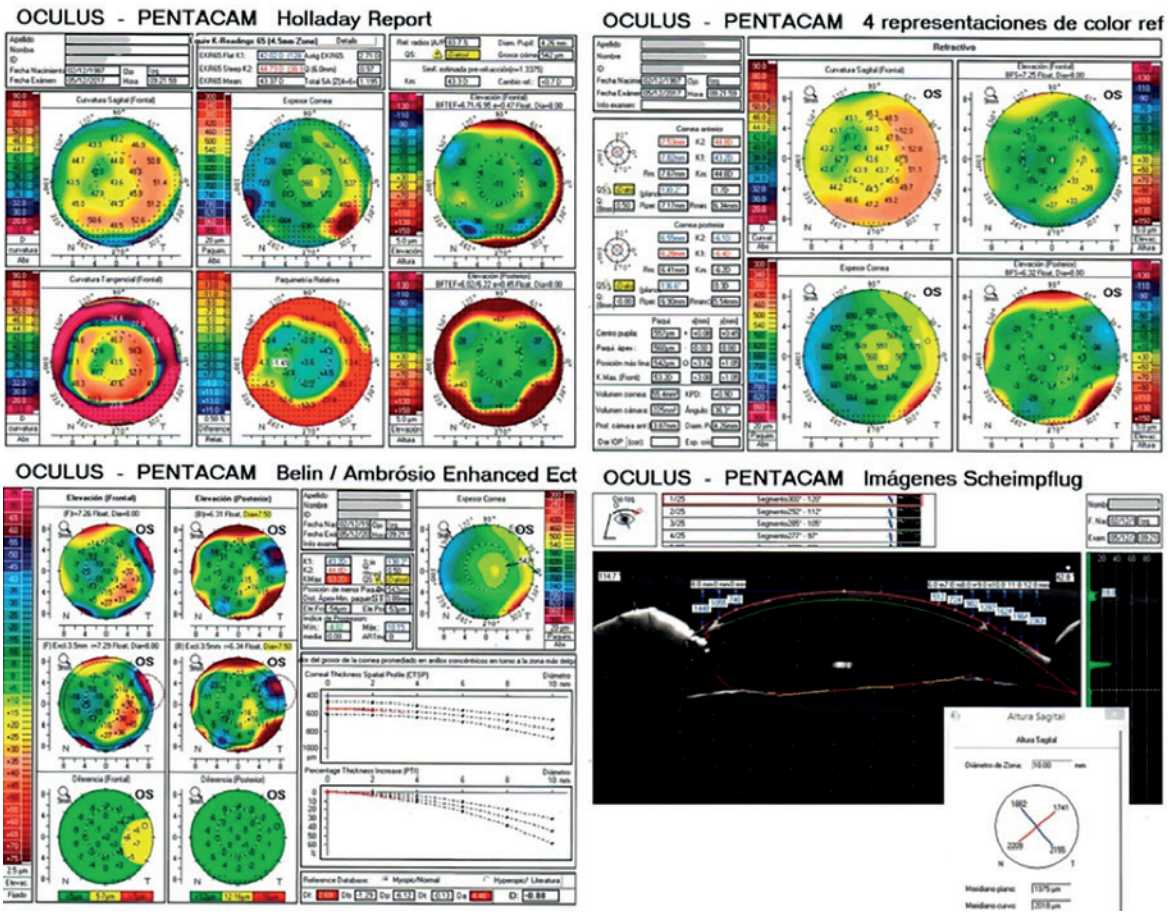


FIGURE 4. **Pentacam LE: A set of elevation maps, refractive maps, Belin/Ambrósio, and Scheimpflug images**

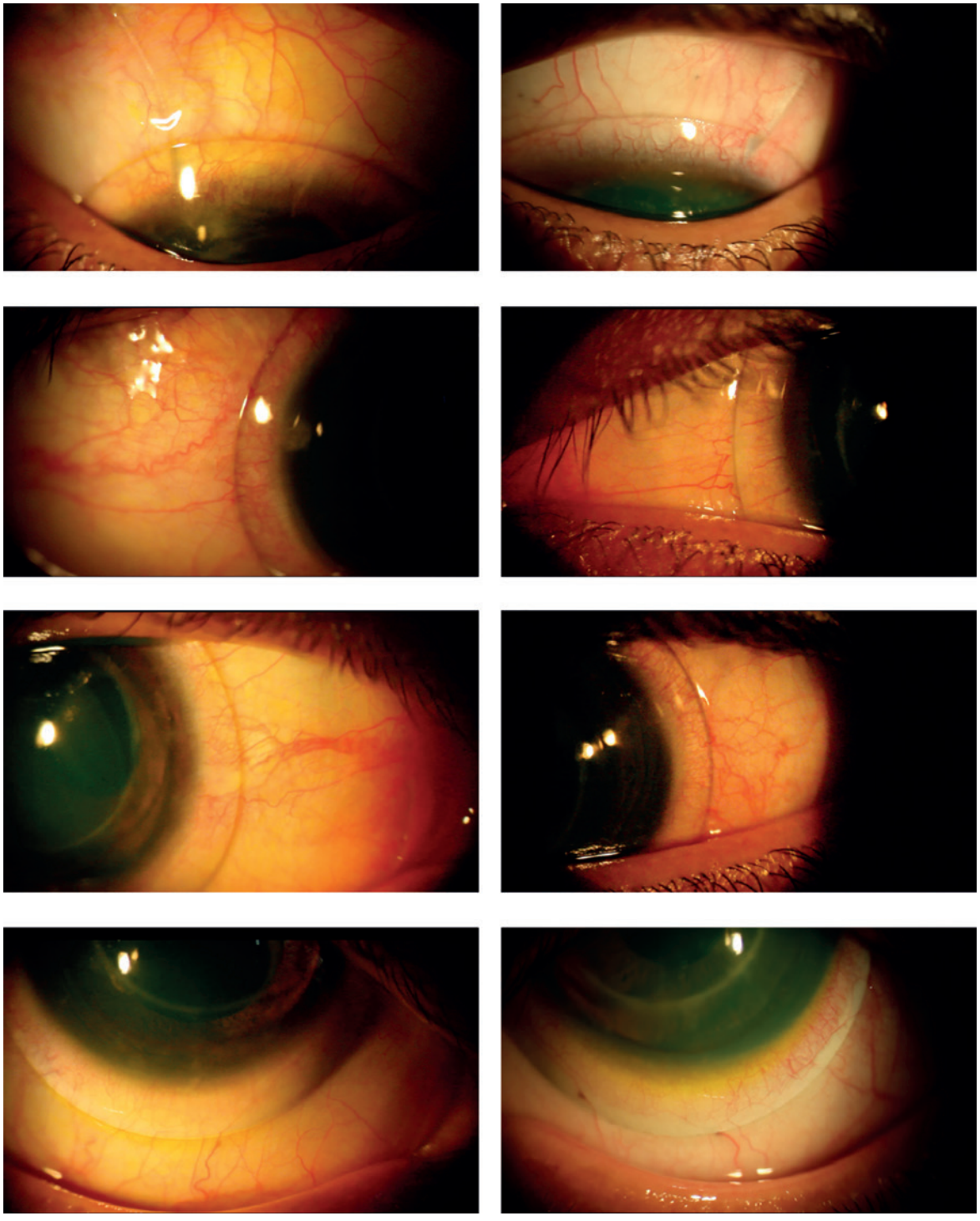
Source: Author's elaboration.

300 µ was observed. It should be clarified that the resource developed by the Michigan College of Optometry (12) was used for the assessment of various lens characteristics to get reliable fitting without risking severe complications (13-15) (Figure 6).

TABLE 2. **Complications with test lenses**

FINDINGS	POSSIBLE COMPLICATIONS	TREATMENT
Blanching	• Vein blockage • Reduced oxygen availability	• Lifting the edges (factors-Flat) • Flattening the lens base curve
Compression on the Ahmed valve	• Silicone tube blockage • Increased IOP	• Notch
Excessive Central Vault	• Hypoxia • Neovascularization • Limbic insufficiency	• Decreasing sagittal height • Changing the base curve (flattening) • Reducing the central curve
Sealed lens	• Suction effect • Difficulty removing the lens • Reduced tear exchange • Inflammation • Reduced oxygen availability	• Lifting the edges • Modifying the limbal and support curve • Modifying the base curve

Source: Walker MK, Bergmanson JP, Miller WL, Marsack JD, Johnson LA. Complications and fitting challenges associated with scleral contact lenses: a review. Cont Lens Anterior Eye. 2016;39(2):88-96.



RE LE

FIGURE 5. **Contact lenses four hours later: Assessment of the landing zone of scleral lenses in the upper, lower, nasal, and temporal quadrants**

Source: Author's elaboration.

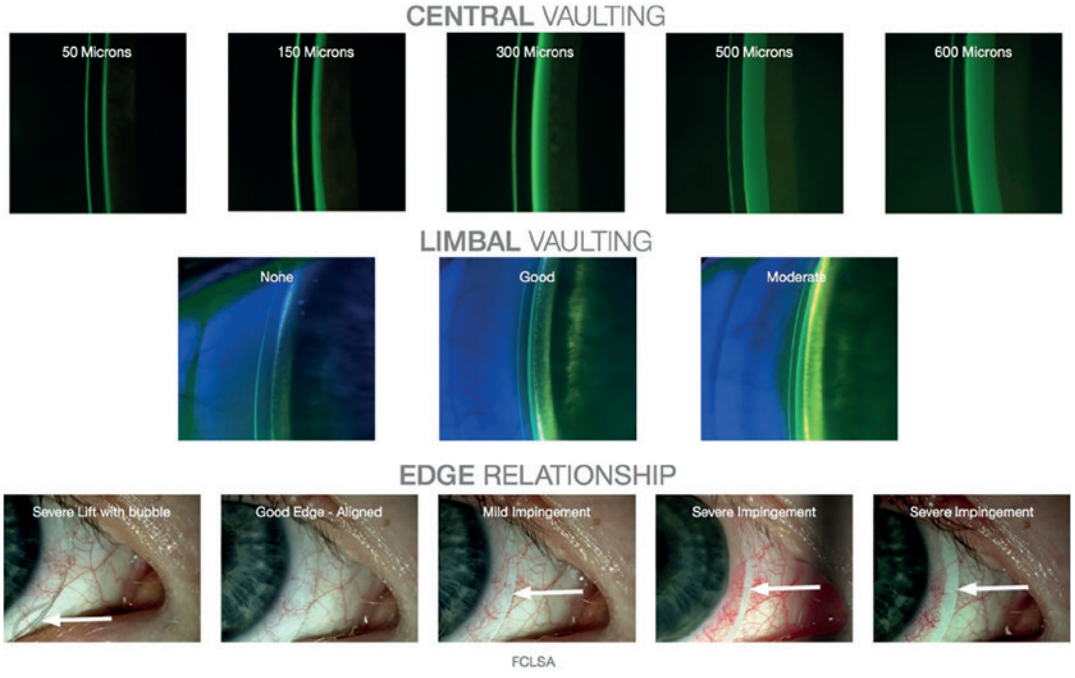


FIGURE 6. **Scleral lens fitting scale**

Source: Josh Lotoczky, Chad Rosen, and Craig W. Norman, Ferris State University Michigan College of Optometry, 2014.

Within the changes made to contact lens parameters (Table 3), a notch was included (figures 7 and 8) towards the superior-temporal areas, seeking to decrease the degree of possible compression on the Ahmed valve, which could affect, to some extent, IOP and, therefore, the patient's glaucoma.

TABLE 3. **Final contact lens parameters**

BC	5.80	**BC**	6.00
Power	–14.50–4.50×20	**Power**	–24.00
Sagitta	5.394	**Sagitta**	5.127
Diameter	15.60	**Diameter**	15.60
Material	Optimum extra	**Material**	Optimum extra
DK	100	**DK**	100
Notch	1.6 V – 1.5 H toward 11 o'clock	**Notch**	1.6 V – 1.2 H toward 1 o'clock

CONTROLS AND FOLLOW-UP

After scleral contact lens fitting, the patient's eyes were constantly monitored. The first control was a week after fitting; a completely calm eye was found, without the presence of blanching, settling, conjunctival prolapse or debris, etc. (14). The cornea was evaluated using a slit lamp with lenses in place and without them. Fluorescein and lissamine green staining was used; and a completely healthy tissue was observed with no signs of keratitis. The second control was performed 15 days after fitting to evaluate lenses (figures 7 and 8), during which the same results were found. The one-month and three-month controls showed similar results.

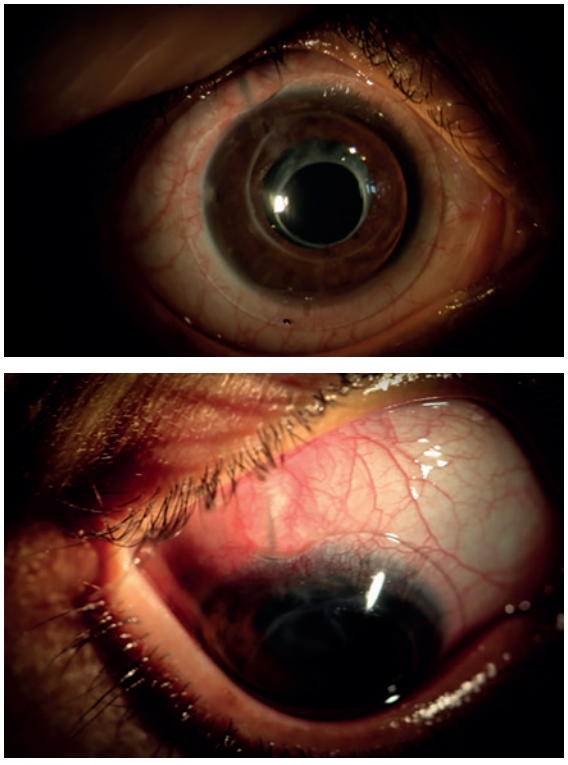


FIGURE 7. **Final contact lens RE**

Source: Author's elaboration.

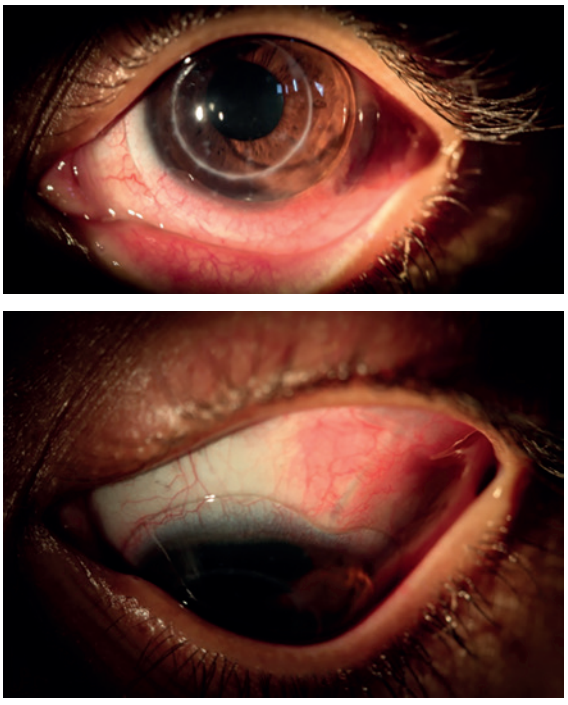


FIGURE 8. **Final contact lens LE**

Source: Author's elaboration.

DISCUSSION

Keratoconus is one of the most common causes of visual morbidity, and although its prevalence and incidence are not entirely clear, some retrospective studies in ethnic groups indicate that this disease is four times more prevalent in Asian patients than in Caucasians. Likewise, patients from the first ethnic group require corneal grafts at a younger age (16). Procedures such as penetrating keratoplasty are currently considered only in advanced cases, in which intrastromal ring placement or other treatments are not recommended due to decreased thickness and great corneal irregularity, which can lead to a rupture of the cornea. But even with these considerations, problems related to the major histocompatibility complex (MHC) remain the most alarming cause of graft rejection. It is worth noting that the function of MHC is to unite and present antigenic peptides to T lymphocytes (3). Thus, given the use of various topical medications to control this mechanism, in some cases, the same drugs used to control transplant rejection have severe adverse effects (17), which in turn can affect the eyeball and its structures and lead to a decrease in the quality of life of patients. But even with all these complications, there are several areas in vision sciences that work cooperatively to perform effective rehabilitation.

The use of postoperative medications in this type of procedures must have a strict and rigorous follow-up, which guarantees the patient's successful surgery and rehabilitation. The adverse effects of medications used after these surgical interventions, such as topical steroids, are widely known. Therefore, great caution must be exercised to avoid causing diseases such as steroid-induced glaucoma or cataract, pathologies observed in this particular case.

In the present case, the serious complications that resulted from an inadequate use of corticosteroids had to be managed by an interdisciplinary group from different areas of vision sciences, such as cornea specialist, glaucoma specialist, and contact lens optometrist. First, keratoplasty procedures were performed, then phacoemulsification and Ahmed valve implantation, and, finally, contact lens fitting; in this case, with a 15.6 mm design (10-12,14) as the best option, since small diameter lenses do not cover the entire area of asymmetry, and possibly they would cause recurrent corneal injuries, which, in turn, would cause severe complications. In addition, a notch (13) was made in the scleral contact lens so as not to obstruct the drainage of aqueous humor through the silicone tube of the Ahmed valve and to control increase in IOP.

Scleral contact lenses provide good visual acuity and comfort, in addition to keeping the donated corneal tissue as healthy as possible. Likewise, it seeks to keep free of obstructions the Ahmed valve adapted for the management of glaucoma. It is important to point out that in the present case, scleral contact lenses were the first option, due to the patient's low tolerance of rigid corneal gas permeable contact lenses, as well as to great corneal asymmetry in patient (13). Likewise, it is important to note that the patient can use scleral contact lenses throughout the day, filling it with saline solution 0.9% free of preservatives in a single dose every five hours. The latter is due to the normal decay of scleral contact lenses.

Finally, it is essential to highlight the necessity of controls or continuous monitoring, which are of vital importance, and more so in this type of patients, who present high risk for postsurgical complications, and who have a psychological predisposition considering the problems that can occur in any type of procedures. Therefore, having a fluid communication with patients will determine the success of contact lens fitting and an improvement in quality of life.

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