Automated Keratopigmentation in Boston Type 1 Keratoprosthesis: An Aesthetic Alternative

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Abstract: Two male patients, aged 64 and 55 years old, presented at the cornea department for a Boston type 1 keratoprosthesis (Kpro I) implantation after multiple corneal graft failures. After surgery, they achieved a best corrected visual acuity of 20/200 and 20/150, respectively. However, they manifested photophobia and aesthetic complaints. Both patients underwent keratopigmentation to improve the aesthetic outcome using vegetable pigments, after mechanical corneal deepithelization, with no intraoperative or postoperative incidents or adverse events. After 1-year follow-up, the patients presented the same best corrected visual acuity with improvement of the aesthetic outcome.

Key Words: keratopigmentation, keratoprosthesis, corneal pigmentation, corneal tattooing

(*Cornea* 2020;39:1578–1580)

Corneal pigmentation, also known as a corneal tattoo, is an aesthetic procedure that has been practiced since ancient times by Galeno and Aethius around 131 AC,[1] who would burn mineral pigmentations, such as iron, over the cornea. Currently, there are similar procedures in which stromal tunnels are created using femtosecond lasers and filled in a later phase with ink.[2]

Current procedures offer a correct corneal aesthetic; however, they are not exempt from complications.[3] Reports have shown patients confirming having light sensitivity, fading or color change, neovascularization, and visual field shrinking.[4] Owing to these side effects, there has been some research looking for new ways of corneal pigmentation and safe and long-lasting ink for the eyes without causing significant complications, such as the case of mineral-irradiated micronized pigments.[5]

The Kpro I is the most commonly used artificial transplant and the transplant of choice for patients who are not candidates for penetrating keratoplasty. Despite obtaining good results in visual acuity, some patients refer dissatisfaction about how the prosthesis looks aesthetically; in addition, some of them refer photic phenomena, such as glare or photophobia; the primary source of these inconveniences is holes on the prosthesis back plate, which allows light to come through, such as in the titanium prosthesis, although they can also be completely transparent, such as the polymethyl methacrylate plates causing even greater light dispersion.[6] Cosmetic contact lens (CL) could be a reasonable option for these patients; however, in our market, the available cosmetic CLs are smaller in diameter and cannot be used permanently in cases of keratoprothesis as therapeutic CLs.

The purpose of these cases was to present a keratopigmentation procedure with sterile plant pigments in patients with Kpro I, which significantly improves their aesthetic appearance and the photophobia reported by those patients.

SURGICAL TECHNIQUE

Once the patients are in the operating theater, iodopovidone 5% is used to clean the eye and border of the eyelids. Sterile eye drapes and sterile fields are placed to avoid any possible contamination. Both patients were operated on under topical anesthesia. Subsequently, a mechanical deepithelization of 7.5 to 8.0 mm of the cornea was performed using a no 15 scalpel, and suture removal was not required. The handpiece is inserted into a finger of a sterile glove with the pierced tip through which the tip of the glove is passed; the cable is kept insulated with sterile plastic sleeve to avoid contamination. Before starting the procedure, the speed is set at 7 mV and displacement depth of the needles at the handpiece is adjusted to 500 μm at the main power supply of the tattoo machine to have a perfect balance between fast and precise work (1–15 mV, with 1 mV being the slowest and 15 mV being the fastest needle stroke frequency). The tip of the handpiece is inserted into the black and brown ink, so the ink impregnates the needles and the cartridge in which they are held, then speed and depth displacement is rechecked, and an iris-like pattern was drawn carefully, always cleaning and seeing how well the ink stained and stayed in the stroma. Tattooing is done by quadrants first between 12 and 9 o'clock and moving counterclockwise. After all quadrants are covered, the cornea is washed and cleaned with balanced saline solution (see Video 1, Supplemental Digital Content 1, http://links.lww.com/ICO/B94). Keratopigmentation technique for Kpro.

All Kpro I patients in our center are handled with bandage CL, vancomycin 5% every 24 hours, preservative-free lubricants, and prednisolone acetate 1% every 4 hours, tapering

Received for publication January 29, 2020; revision received May 24, 2020; accepted June 21, 2020. Published online ahead of print August 26, 2020.
From the Research Department, Oftalmosalud Institute of Eyes, Lima, Peru.
The authors have no funding or conflicts of interest to disclose.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.corneajrnl.com).
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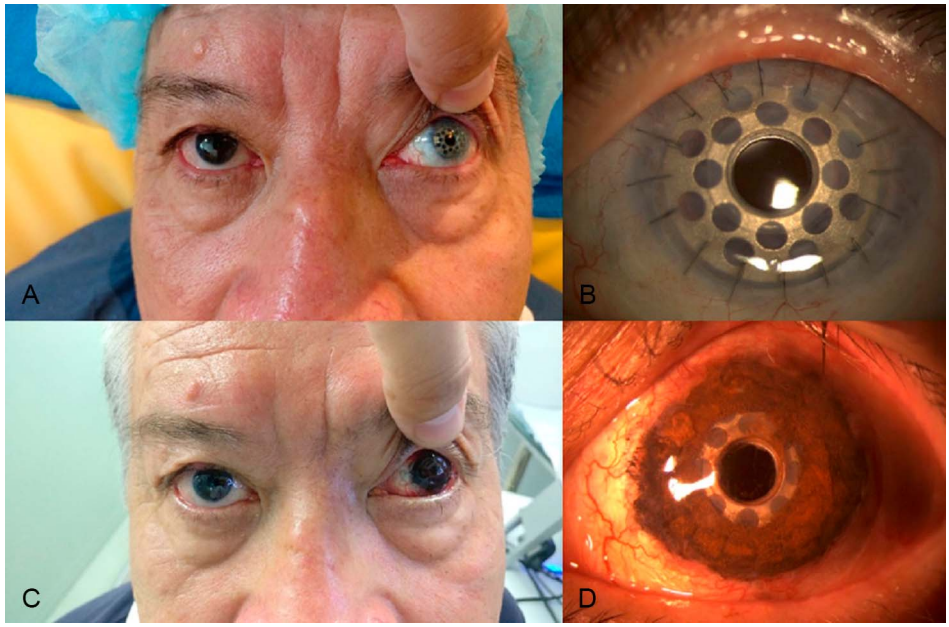

FIGURE 1. A, Kpro I left eye before to keratopigmentation. B, Slit-lamp picture. C, First day postkeratopigmentation. D, Slit-lamp picture. (The full color version of this figure is available at www.corneajrnl.com.)

according to the follow-up. In addition, after the keratopigmentation procedure, they were required to wear an eye patch for 24 hours, continuing the treatment with sodium hyaluronate 0.4% every 3 hours, moxifloxacin 0.5% every 4 hours, and prednisolone acetate 1% every 4 hours. The bandage CL was changed after 1 week. The follow-up was scheduled for the next day, then weekly for 1 month, and then monthly for 12 months.

INKS AND EQUIPMENT

We used a dermal tattooing machine (EZ Tattoo, Beijing, China) with a power supply (EZ Tattoo): output power: 0 to 15 DC-1A; input power: 110 to 240 V AC, 50/60 Hz; and 1203RL caliber dermal needles (EZ Tattoo). The inks used were "Dark Chocolate" (Intenze, Chicago, IL) composed of Aqua, dye C.I.77491, dye C.I.77266, glycerine, isopropyl alcohol, and Hamamelis Virginiana, and "True Black" (Intenze) composed of Aqua, dye C.I.77266, glycerine, isopropyl alcohol, and Hamamelis Virginiana, both inks under regulation by the Council of Europe, Resolution ResAP(2008) on requirements and criteria for the safety of tattoos and permanent make-up and tested for dye components (Dyestuffs acc. to CoE Resolution ResAP(2008)), sterility (Sterility acc. to CoE Resolution ResAP(2008)), heavy metals (Heavy Metals acc. to CoE Resolution ResAP(2008)), aromatic amines and carcinogens (Aromatic amines and carcinogens acc. to CoE Resolution ResAP(2008)), and polycyclic aromatic hydrocarbons y benzo-a-pyrene. The total cost was approximately 500 USD including a multiple use device and single-use consumables for 15 USD.

Case 1

A 64-year-old man presented with a medical history of 3 corneal transplants in the left eye and chronic glaucoma with the Ahmed glaucoma valve in which Kpro I with a titanium back plate (Figs. 1A, B) was implanted achieving up to 20/200 best corrected visual acuity (BCVA) without any complications. After 1-year follow-up, BCVA was 20/200 with no complications related to the Kpro procedure; aesthetic dissatisfaction and manifested photopic discomfort were reported. A corneal keratopigmentation procedure was performed with no intraoperative complications. Krytantek (timolol 0.5%, brimonidine 0.2%, and dorzolamide 2%) every 8 hours was continued. At the first postoperative day, satisfactory pigmentation of the donor cornea without significant areas of depigmentation (Figs. 1C, D), presenting moderate conjunctival inflammation, mild ocular pain, BCVA of counting fingers, and pigment behind the CL, was evidenced at biomicroscopy, so the CL was replaced and BCVA of 20/200 was achieved the next day. At 7 days, postoperatory reepithelization was complete. At 1- and 12-month follow-ups, BCVA was 20/200, biomicroscopy shows correct pigmentation of the cornea, and the patient did not present photopic discomfort. The patient reported total satisfaction regarding the aesthetic outcome.

Case 2

A 55-year-old man presented with a medical history of glaucoma, 4 failed corneal transplants, and pseudofaquic, in which Kpro I was implanted (Fig. 2A). Two months after the Kpro I implantation, the patient reached a BCVA of 20/150 but reported aesthetic dissatisfaction and the persistence of glare and great aesthetic compliance. After the 10-month follow-up, corneal keratopigmentation was performed without any intraoperative complications. Krytantek every 12 hours was continued postoperatively. On the first postoperative day, the BCVA was counting fingers, which improved to 20/150 at 7 days postoperatively and complete reepithelization. The patient reported perceiving a reduction in glare and great aesthetic compliance. One month and 12 months after the procedure, the patient had a BCVA of 20/150, without discomfort and glare and with a correct pigmentation in the cornea (Fig. 2B). Blepharoplasty was

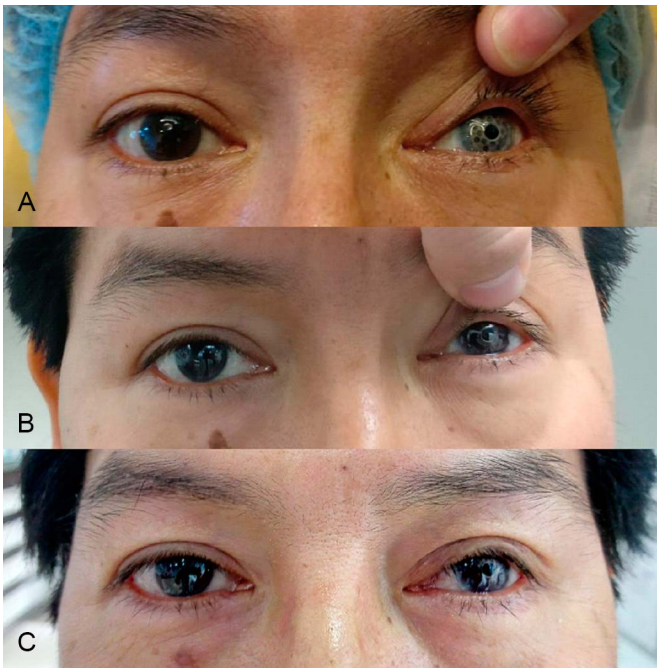

FIGURE 2. Left eye with Kpro before (A) and after (B) keratopigmentation. C, After blepharoplasty. (The full color version of this figure is available at www.corneajrnl.com.)

performed to correct previous ptosis 2 months after keratopigmentation with no complications (Fig. 2C).

DISCUSSION

Corneal keratopigmentation procedures are far from recent; this aesthetic procedure has been practiced since ancient times by Galeno and Aethius around 131 AC. There are 2 main types of keratopigmentations: superficial (superficial corneal staining and superficial automated keratopigmentation) and intrastromal (manual intrastromal keratopigmentation and femtosecond-assisted keratopigmentation).[1,2] Although the use of the femtosecond-assisted keratopigmentation has been widely diffused, we prefer the automated puncture staining spot by spot because it allows us to create texture nuances achieving natural aesthetics with as many colors as we would like and also a layer of stromal pigmentation of proper thickness to block light from coming through. This differs from other techniques that allow the application of one uniform color only and require 2 tunnels of different depths to block the light.[2] In the same way, we think that our technique, in the particular instance of the Kpro I, could be even safer because it allows for better coloration without compromising the optical cylinder and avoiding the potential risk of tunnel stretching to the edge of the corneal cylinder.

Several articles have discussed the importance of the pigments used; refer to the study of Alio et al,[4] which mentioned the use of mineral inorganic pigments over vegetable pigments. Although it has been observed that mineral pigments do not discolor through time, they can manifest adverse effects, such as photophobia and delayed reepithelialization. On the other hand, although the ancient vegetable pigments used in skin tattoos suffer from long-term discoloration, the new-generation vegetable pigments are more durable and do not suffer discoloration.[7] For this reason, using new-generation vegetable pigments in combination with a technique that achieves a penetration of the pigment of at least half the corneal thickness yields a better permanence of the ink in the corneal stroma, resulting in a durable and optimal aesthetic outcome.

Another aspect to take into account is the subjective decrease in glare with this technique. Glare can develop because of light scattering through keratoprosthesis,[8] either titanium or polymethyl methacrylate, that is often being reported by patients as a nuisance. Although one limitation of our study is that we did not measure the glare objectively, the patients reported relief of the glare; however, it is necessary to carry out further follow-up and evaluate this improvement of glares and its behavior and eventual long-term complications.

To the best of our knowledge, this is the first report of keratopigmentation in patients with Kpro I, resulting in a permanent and less expensive solution to improve aesthetic compliance.

More studies are needed to clearly establish the long-term safety profile of this technique and for a correct standardization of the technique, for example, setting the depth of needle penetration in relation to the corneal thickness.

ACKNOWLEDGMENT

The technical support from Carmen Maldonado is acknowledged.

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