Sutureless superficial anterior lamellar keratoplasty in a patient with epithelial-stromal dystrophy

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ABSTRACT: A case report of corneal epithelial-stromal dystrophy managed with microkeratome- and femtosecond laser-assisted two-stage anterior lamellar keratoplasty. Two surgical procedures were performed. In the first, a corneal flap was created using a microkeratome. After 9 weeks, the flap depth was measured by optical coherence tomography and a 7.5-mm central trephination was performed to that depth. At this point, the trephined disk was removed. A similar thickness donor disk that had been obtained minutes earlier with femtosecond laser was then placed in the surgical bed. No sutures were used. The procedure described significantly improved the patient's visual acuity and ocular symptoms from the first postoperative week. This technique is a good option for patients with epithelial-stromal corneal dystrophies, improving visual acuity and ocular symptom relief, with the option of transplanted disk replacement in the future in the event of dystrophy recurrence.

The corneal dystrophies are a heterogeneous hereditary, non-inflammatory, slowly progressive, bilateral and symmetric group of pathologies[1,2].

The latest classification categorizes corneal dystrophies based on the histological layer involved: epithelial and subepithelial, epithelial-stromal transforming growth factor beta-induced (TGFBI), stromal, and endothelial[1].

Reis-Bücklers corneal dystrophy (RBCD) is an autosomal dominant, category-1 dystrophy, characterized by the presence of keratoepithelin in immunohistochemistry studies. It belongs to the previously denominated Bowman's dystrophies category, better known today as epithelial-stromal TGFBI dystrophies, because the area involved is not limited to the Bowman's membrane, but also extends to the epithelium and anterior stroma[1,2].

Thiel-Behnke corneal dystrophy, which also belongs to the epithelial stromal TGFBI dystrophies, seems to be more frequent than RBCD, but has less visual impact, later appearance and lower rate of recurrence after surgical interventions[3].

However, it is very hard to differentiate clinically between these two conditions. Differences can be seen only when performing electron microscopy, which reveals curved collagen fibres in the case of Thiel-Behnke, instead of the classic cylindrical or trapezoidal structures in RBCD[3,4,5].

Treatment of the epithelial-stromal TGFBI dystrophies has two main aims: improving visual acuity (VA) and relieving symptoms secondary to epithelial defects. Therapeutic options[6] include both non-surgical (ocular lubricants, ointments, contact lenses) and surgical approaches (phototherapeutic keratectomy [PTK], penetrating keratoplasty and conventional and pre-Descemet lamellar keratoplasty).

Among the proposed surgical treatments for epithelial-stromal TGFBI dystrophies, anterior lamellar keratoplasty, a surgical technique that had fallen into relative disuse, has gained increasing acceptance thanks to new instrumentation and technology.

Not long ago, anterior lamellar keratoplasties were done strictly by hand, which required not only an enormously experienced and skilled surgeon, but often created an irregular surgical interface, yielding suboptimal optical outcomes. This has been changing for some years now with the use of the microkeratome and femtosecond laser which, by producing smoother and more precise surgical beds, allow for better visual rehabilitation[7-12].

We describe a case of epithelial-stromal TGFBI Reis-Bücklers/Thiel-Behnke corneal dystrophy managed with anterior superficial lamellar keratoplasty without sutures that was performed in two stages using a microkeratome and femtosecond laser.

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CASE PRESENTATION

A 23-year-old man presented to our cornea service with severe bilateral photophobia and epiphora. He had had poor visual acuity (VA) since childhood and a previous medical history of penetrating keratoplasty in the left eye (OS) when he was 11 years old, and phototherapeutic keratectomy (PTK) in both eyes plus an amniotic membrane graft in OS at the age of 18.

At that time his VA was 20/100 in the right eye (OD) and counting fingers at 2 meters OS; refraction was impossible due to corneal surface irregularity, photophobia and epiphora. Both eyes had confluent corneal opacities that encompassed the central 6 mm and were located at the level of Bowman's layer, with extension to both the anterior stroma and epithelium. A non-rejected penetrating keratoplasty was observed in the left eye with the findings described, both in the graft and in the recipient's cornea (Figures 1 and 2).

Optical coherence tomography (OCT) showed opacities up to a depth of 156 μm OD and 170 μm OS (Figure 3).

A clinical diagnosis of epithelial-stromal TFGBI corneal dystrophy (Reis Bücklers/Thiel Behnke) was made.
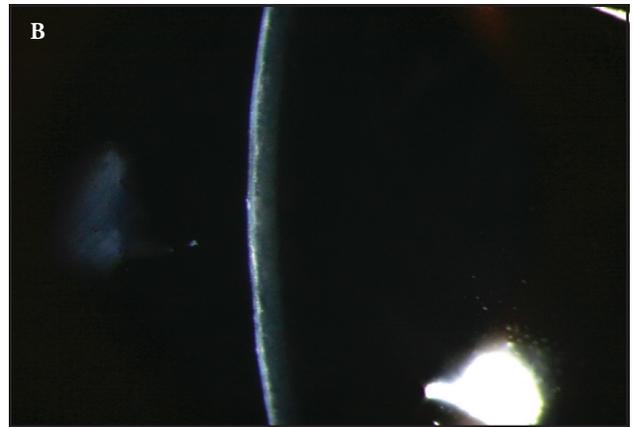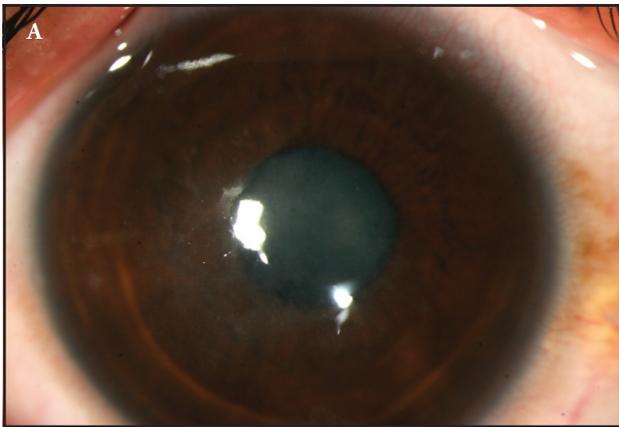
Figure 1. OD. (A) Centrally located geographic opacities; (B) Slit lamp showing opacities at the level of Bowman's layer and superficial corneal stroma.
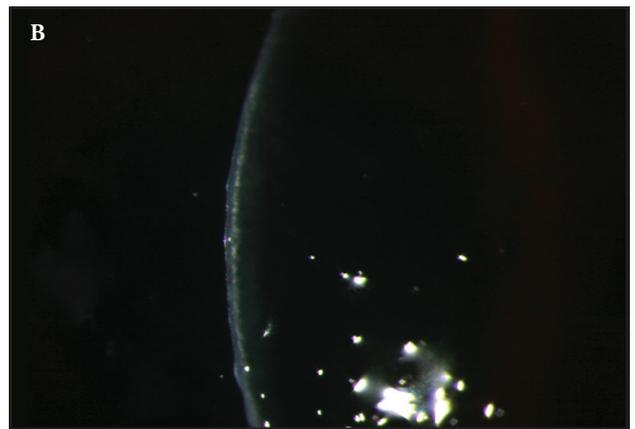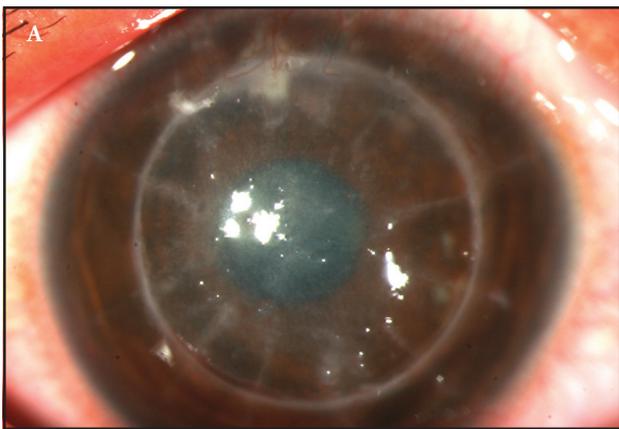
**Figure 2**. OS. (A) Penetrating keratoplasty with dystrophy recurrence. (B) Slit lamp showing opacities at the level of Bowman's layer and superficial corneal stroma, as well as epithelial irregularity.
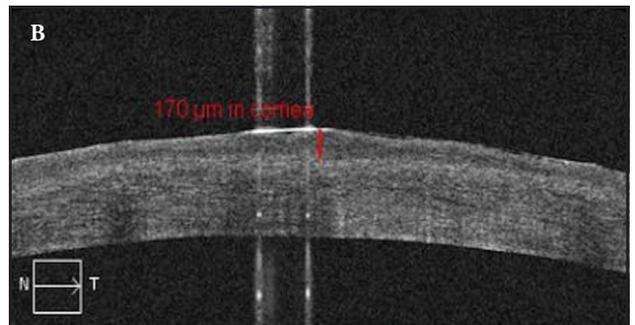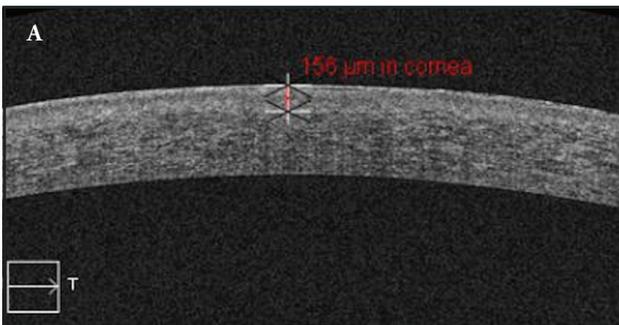
Figure 3. Preoperative OCT shows the presence of opacities (A) up to 156 μm OD and (B) 170 μm OS.
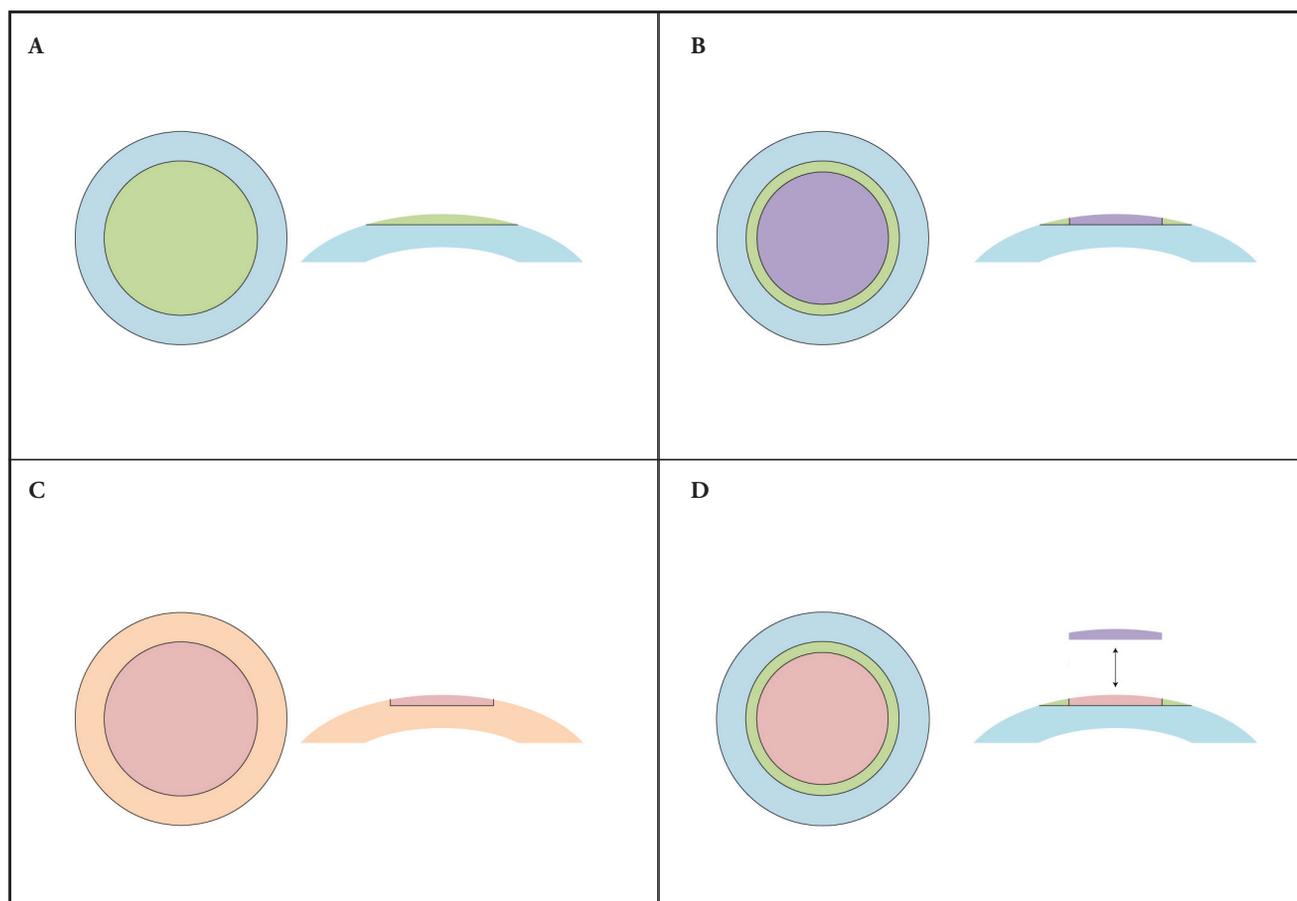
Figure 4. (A) Recipient flap creation and repositioning. (B) Trephination on the previously created flap and removal of lenticle. (C) Donor corneal button creation by femtosecond laser. (D) Donor lenticle positioning in the recipient bed.
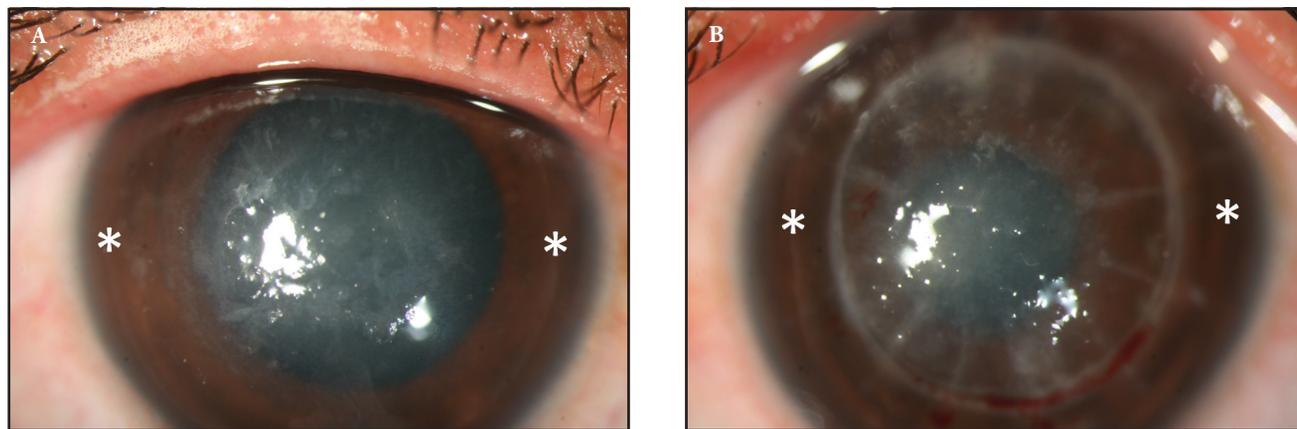
Figure 5. First-stage early postoperative (A) OD and (B) OS. Temporal and nasal edges of the corneal flaps are shown (white asterisks).

Surgical technique

Two-stage microkeratome- and femtosecond laser-assisted superficial anterior lamellar keratoplasty was performed (Figure 4).

First stage: A 9-mm corneal flap was created under topical anaesthesia (proparacaine hydrochloride 0.5%, Alcaine; Alcon Cusi S.A., El Masnou, Barcelona) using an automatic microkeratome (Lasik M2; Moria S.A., Antony, France) with a 130 µm head, LC ring, and slow speed. The flap was repositioned and a contact lens (O2 Optix; Alcon) was left in place for 24 hours. Sodium hyaluronate 4 mg/mL (Lagricel; Sophia S.A., Guadalajara, Mexico) and tobramycin 0.3% + dexamethasone 0.1% (Tobradex; Alcon) 5 times daily were prescribed (Figure 5). Six weeks later, a new OCT was carried out, showing a flap depth of 209 µm OD and 207 µm OS (Figure 6).

Second stage: Nine weeks after the microkeratome flap creation, a corneal graft measuring 7.5 mm in diameter and 200 μm in depth was obtained with femtosecond laser (Wave Light FS200; Alcon) from a cadaveric donor. Immediately afterwards, the patient was taken to the operating room, where a central 7.5-mm trephination was performed (Hessburg-Barron trephine; Barron Precision Instruments, LLC, Grand Blanc, MI, USA) under general anaesthesia, to the depth of the effective microkeratome cut according to the corneal OCT. The 7.5-mm trephined button was removed easily in both eyes and without distorting the previous graft scar in the OS. The lamellar donor graft obtained with femtosecond laser was then positioned in the trephined bed. The edges were dried with sponges (Weck-Cel; Beaver-Visitec International, Inc., Waltham, MA, USA) and a contact lens (O2 Optix; Alcon) was left in place for 3 weeks. Sodium hyaluronate 4 mg/mL (Lagricel; Sophia) and tobramycin 0.3% + dexamethasone 0.1% (Tobradex; Alcon) 5 times daily were continued.

The recipient's excised corneal specimens were histologically studied (Dr. Francisco Barraquer Coll, Barraquer Institute of America, Bogotá, Colombia)
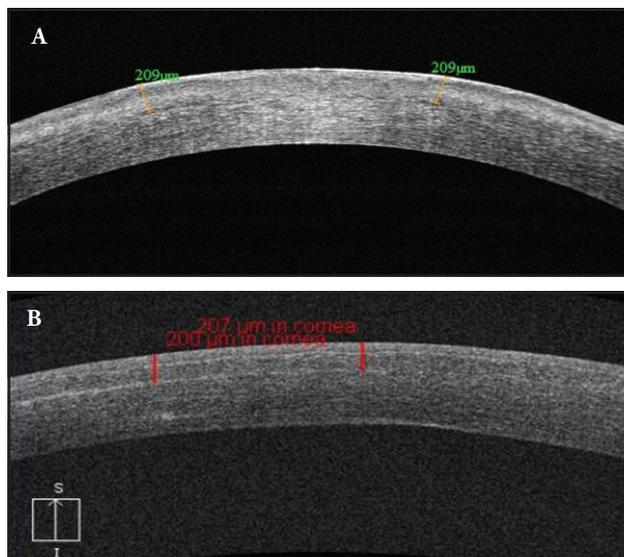
Figure 6. First-stage postoperative OCT shows (A) depth of 209 μm OD and (B) 207 μm OS for the flaps previously created.

Figure 7. Recipient histological specimen OS (Courtesy of Dr. Francisco Barraquer Coll, Barraquer Institute of America, Bogota, Colombia.

and showed variable thickness corneal epithelium with multiple interruptions, absence of Bowman's layer in some areas, and presence of amorphous granular material in the anterior stroma and epithelium. These findings were consistent with the provisional diagnosis (Figure 7).

Results

The patient's symptoms and VA improved from the first postoperative week. The corneal surface became smoother and refraction could be performed, achieving a best corrected VA of 20/30 OD and 20/70 OS after 2 months. Both grafts remained in position, transparent, and with a clean interface during the follow-up period (Figures 8 and 9).

Eight weeks after the second-stage, a new OCT was performed, showing absence of residual stromal opacities and a regular surface (Figure 10).

DISCUSSION

The corneal epithelial-stromal TGFBI dystrophies lead to severe recurrent epithelial erosions and significant loss of VA due to corneal opacities and irregular astigmatism. Multiple treatment modalities have been described for the management of this condition, including ocular lubricants, contact lenses, PTK, and penetrating and lamellar (conventional and pre-Descemet) keratoplasties.

When non-surgical treatment is not enough, surgical options are used. PTK has been used for many years because it is minimally invasive, effective, safe and repeatable[13-15]. However, it also has disadvantages, such as the risk of corneal haze, induction of hyperopia[6,14,16] and a high recurrence rate that can reach 47% during the first year after treatment[17]. Moreover, it is a procedure in which the number of repetitions is limited by the corneal thinning caused by each intervention[14].

The aim of corneal transplant is to replace the diseased cornea with healthy donor corneal tissue[18]. Compared to PTK, it is a more invasive procedure and technically more demanding, with the same risk of recurrence[6].

Conventional lamellar keratoplasty has the advantage of preserving the recipient's endothelium, thereby reducing the risk of rejection[6,18,19]. However, the manual separation of the corneal layers leads to the creation of an irregular bed with poor refractive results[10,19].

The more recent lamellar pre-Descemet keratoplasty, frequently used in the last 15 years, also preserves the corneal endothelium and allows final VAs that are just as good as those of the penetrating grafts, because the bed obtained is smooth and regular[7-9,20]. However, they are technically difficult and the repeatability without breaking the Descemet's membrane is poor.

Similar cases managed with lamellar keratoplasty have been reported previously, some   in a two-stage
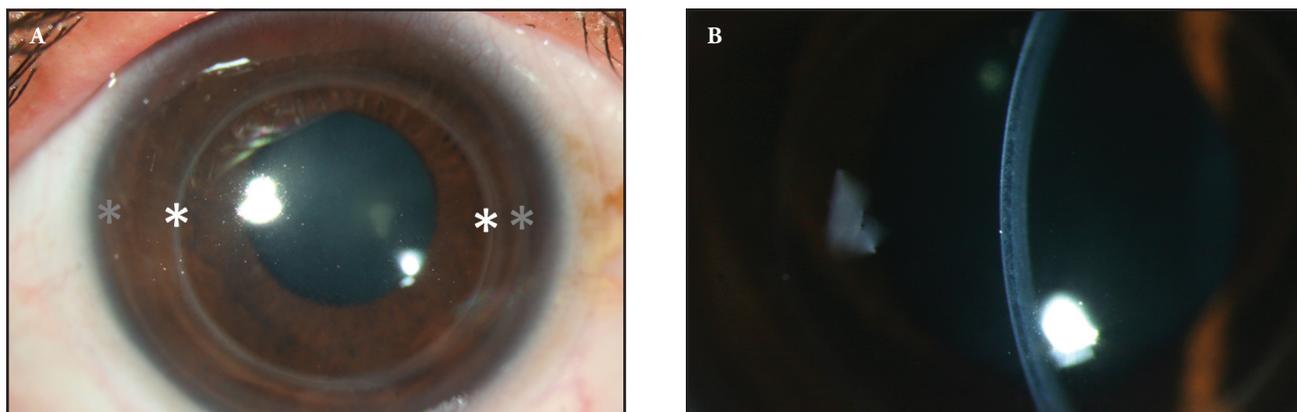
Figure 8. Second-stage postoperative OD. The nasal and temporal edges of the flap can be observed (grey asterisks) as well as implanted lenticle edges (white asterisks). (A) Slit lamp without opacities or (B) epithelial surface irregularities.
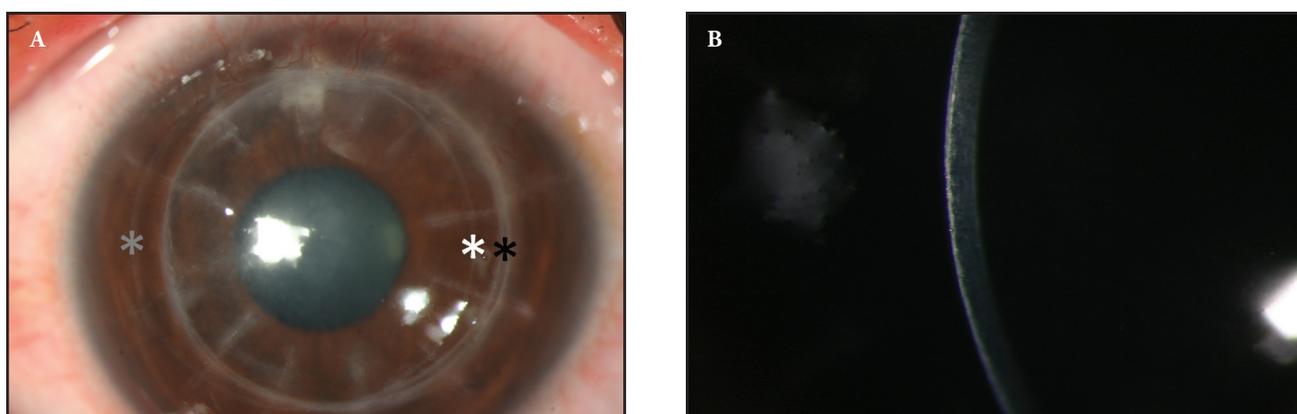
Figure 9. Postoperative pictures after the second-stage of the procedure OS. Previous penetrating keratoplasty (black asterisk), as well as initial flap (grey asterisk) and implanted lenticle (white asterisk) borders are evident. (A) Slit lamp without opacities or (B) epithelial surface irregularities.
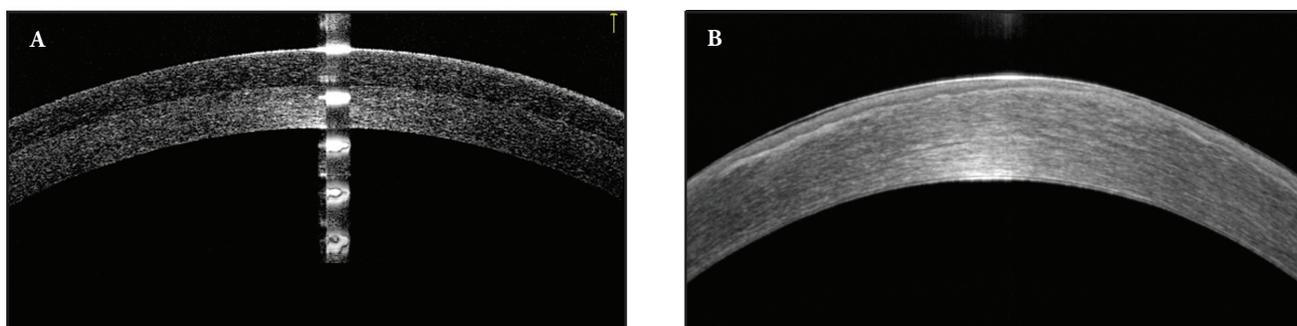
Figure 10. Second-stage postoperative OCT.

procedure using the microkeratome[21], while in others, both removal of the diseased cornea and procurement of the donor lenticle were done in a single-stage procedure using femtosecond laser[22-24]. This was not applicable in our patient, as the opacity of the corneal dystrophy precluded laser penetration and cut; furthermore, the quality of the stromal bed obtained with femtosecond laser has been questioned by some authors[25,26].

We decided to use a Moria M2 microkeratome with a 130 μm head, knowing that the opacities were at a depth of 160-170 μm, because it has been shown that the cut depth obtained with this microkeratome combination varies between 150 and 170 μm[27-29], sometimes reaching values even above 200 μm, especially when using the slow speed mode[27,28]; in our case, we achieved cut depths close to 170-180 μm, enough to remove the stromal opacities recorded in the preoperative OCT.

We choose to wait for 9 weeks after microkeratome flap creation before proceeding with the trephination, to make sure that the flap would not distort or lift on

trephining; this was merely a precaution as we had no experience with this surgical technique. Unlike previously published cases, the trephination depth in the recipient with a Hesburg-Barron trephine, as well as the thickness of the donor lenticle with the femtosecond laser, were made based on the real cut depth obtained with the microkeratome, as determined in the OCT. This was in order to achieve a more equitable trephination of the recipient and donor button, so that the original thickness of the cornea can be preserved[30-32].

The technique described allows for rapid improvement of VA and ocular symptoms, with a low risk of rejection. Moreover, because this is a sutureless technique, it avoids suture-related complications such as infection, dehiscence, neovascularization and astigmatism. Another advantage is the possibility of replacing the lamellar graft if the dystrophy recurs, by simply peeling it away and placing new one, with no reduction in corneal thickness or Descemet's membrane rupture. Longer follow-up will be required before we can determine how stable and for how long the refractive result obtained will last.

In conclusion, we believe that the above-mentioned technique represents an excellent option for managing corneal epithelial-stromal TGFBI dystrophies.

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