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# Interface Fluid Syndrome After Descemet Membrane Endothelial Keratoplasty in Patients With History of LASIK

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**Purpose:** The aim of this study was to evaluate the visual, pachymetric, tomographic, and biomicroscopic findings in a series of cases with laser in situ keratomileusis (LASIK) flap interface fluid syndrome (IFS) after Descemet membrane endothelial keratoplasty (DMEK).

**Methods:** Six cases were included in this study; all patients had a history of LASIK and underwent DMEK for the treatment of bullous keratopathy. After uneventful surgery, all patients presented with corneal edema and IFS under the LASIK flap, which was demonstrated with anterior segment optical coherence tomography (AS-OCT). Visual acuity, clinical findings, pachymetry, endothelial cell count, and AS-OCT were documented during the management of these cases.

**Results:** IFS appears 2.33 days (±1.03) after DMEK. One case improved with conservative treatment. In 5 cases, the LASIK flap was lifted, the fluid was drained, and the flap was replaced. The mean best-corrected visual acuity after fluid drainage was 0.44 logMAR (range 0.18–1.0) and mean central corneal thickness was 538 μm ± 160. Total resolution of the IFS was achieved at 14.5 days (range 4–30) after DMEK. AS-OCT showed resolution of the flap interface in 5 of 6 cases, while 1 patient required second DMEK due to reaccumulation of the interface fluid.

**Conclusions:** IFS can occur after DMEK in patients with previous LASIK. AS-OCT is a valuable tool for monitoring these cases preoperatively and postoperatively. Early surgical management is often needed to achieve resolution.

**Key Words:** Descemet membrane endothelial keratoplasty, interface fluid syndrome, postlaser in situ keratomileusis, anterior segment optical coherence tomography

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The alteration in corneal architecture due to the laser in situ keratomileusis (LASIK) flap in patients having LASIK represents a challenge for certain ocular conditions, such as the potential risk to misdiagnose glaucoma disease[1] and predictability of the refractive outcome of cataract surgery.[2] The implications of having a history of LASIK in patients who undergo Descemet membrane endothelial keratoplasty (DMEK) are unknown.

Interface fluid syndrome (IFS)[3] is a condition occurring in patients after LASIK, in which retention of fluid in the LASIK flap interface occurs. The proposed mechanisms are the increase of intraocular pressure (IOP)[4–9] and corneal endothelial cell failure without high IOP.[10,11] DMEK has been reported as a surgical treatment in patients with IFS to address endothelial failure,[10,11] and IFS has been reported after an early failed Descemet stripping automated endothelial keratoplasty graft[10]; however, to the best of our knowledge, our case series is the first reporting IFS after DMEK.

Taking into account in the past 25 years 20 to 25 million eyes had LASIK, around 800,000 eyes have had LASIK each year for the past 10 years,[12] and DMEK has become the most popular alternative for endothelial transplantation, maybe in the future it will not be so exceptional to have patients with a history of LASIK who require DMEK. The purpose of this study was to describe the course and treatment of 6 post-LASIK patients who developed liquid interface syndrome after uneventful DMEK.

## METHODS

It was a retrospective case series study, including patients with a history of LASIK who underwent DMEK to treat bullous keratopathy and after uneventful surgery presented IFS under the LASIK flap confirmed by anterior segment optical coherence tomography (AS-OCT). All cases were seen at Oftalmosalud Instituto de Ojos, Lima, Peru, between 2018 and 2021.

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All patients underwent a DMEK procedure under the double-scroll technique.[13] Preoperative and postoperative evaluation include visual acuity, slit-lamp examination, AS-OCT (MS 39, CSO, Florence, Italy), pachymetry (MS 39, CSO), and endothelial cell count (CEM-530, Nidek, Gamagori, Japan) and IOP assessment with a Goldmann tonometer. The study complied with the Declaration of Helsinki. The Ethics Committee of Oftalmosalud approved the study and obtained written informed consent from all patients before surgery.

## RESULTS

Six patients (6 eyes) came to our clinic with medium- to high-grade corneal edema in which bullous keratopathy was diagnosed, and a DMEK procedure was indicated. All 6 patients had a history of LASIK and additional intraocular surgery [either phacoemulsification or phakic intraocular lens (pIOL) implantation]. The mean patients age was 48.8 years (±14.3), 50% (3 patients) were men.

At preoperative evaluation (before DMEK), mean best-corrected visual acuity (BCVA) was 1.23 ± 0.56 logarithm of the minimum angle of resolution (LogMAR), mean of Goldmann applanation tonometry was 14.33 mm Hg ±1.51, and mean central corneal thickness was 671.66 μm ± 28.58. All 6 cases had a normal AS-OCT finding and normal post-LASIK flap, with no IFS. Table 1 shows the clinical and preoperative data of the 6 patients. Figure 1A shows pre-AS-OCT with no IFS, and Figure 1B shows the IFS after DMEK.

All cases underwent uneventful DMEK. pIOL was removed in patients in whom corneal decompensation was due to the pIOL. The mean graft diameter was 8.04 mm (±0.18) and mean descemetorhexis diameter of 8.50 mm (±0.56). Five of 6 cases did not require any additional manipulation to place the donor tissue; only 1 case required a rebubble a day after the surgery to reattach the DMEK graft which was partially detached. In a mean time of 2.33 days (±1.03) after DMEK, all patients presented decreased visual acuity and corneal edema (range + to +++). AS-OCT demonstrated IFS in all 6 cases. When fluid interface was present, the mean BCVA was 1.42 logMAR (±0.43), mean corneal thickness was 777 μm (±159), mean flap thickness was 161 μm (±33), and mean fluid interface was 104 μm (±38.7). DMEK graft was fully attached in 5 of 6 cases and partly detached in 1 case (1/6). Table 2 shows visual acuity, IOP, and AS-OCT corneal characteristics at the time of the IFS presentation.

## IFS Management

In all cases, initial treatment was conservative, including oral acetazolamide (250 mg, 3 times per day), timolol 0.5% twice daily, and sodium chloride drops 4 times per day. In only 1 case, this conservative treatment was enough to resolve IFS and no surgical treatment was needed.

The first case presented in our setting was addressed with venting incisions which did not resolve IFS, and flap lifting was required. Five of 6 cases required surgical intervention to drain the fluid from under the LASIK flap. In 4 of 5 cases, only 1 flap lifting was required to resolve IFS; however, in 1 case, additional flap lifting was needed to drain the fluid (because IFS reappeared 5 days after the first

**TABLE 1.** Preoperative Characteristics of the Eyes Before DMEK was Indicated

| Case | UCVA (LogMAR) | BCVA (LogMAR) | Specular Microscopy (cells/mm²) | CCT Pre-DMEK | Corneal Edema |
|---|---|---|---|---|---|
| 1 | 1.60 | 1.30 | Not valuable | 710 | +++ |
| 2 | 2.0 | 1.60 | Not valuable | 680 | +++ |
| 3 | 1.30 | 1.30 | Not valuable | 670 | +++ |
| 4 | 0.70 | 0.70 | 518 | 650 | ++ |
| 5 | 2.0 | 2.0 | Not valuable | 630 | ++ |
| 6 | 0.70 | 0.48 | 457 | 690 | +++ |

| Case | Years Since LASIK | Flap Creation | Other Previous Ocular Qx* | Years Since Previous Ocular Qx* | Pre-DEMK IOP (mm Hg) | Preoperative Diagnosis |
|---|---|---|---|---|---|---|
| 1 | 10 | MK | Phacoemulsification | 2 | 14 | PBK |
| 2 | 12 | MK | AC pIOL** implantation | 12 | 14 | Corneal decompensation |
| 3 | 12 | MK | AC pIOL implantation | 12 | 12 | Corneal decompensation |
| 4 | 16 | MK | AC pIOL** | 16 | 14 | Corneal decompensation |
| 5 | 2 | FS-laser | Phacoemulsification and 4 months later IOL implantation | 3 | 16 | PBK |
| 6 | 7 | FS-laser | AC pIOL** implantation | 7 | 16 | PBK |

*Surgeries different than LASIK.
**Artisan (Ophtec).
AC, anterior chamber; CCT, central corneal thickness; Cf, counting fingers; FS-laser, femtosecond laser; IOL, intraocular lens; MK, microkeratome; PBK, pseudophakic bullous keratopathy; Qx, surgery; UCVA, uncorrected visual acuity.

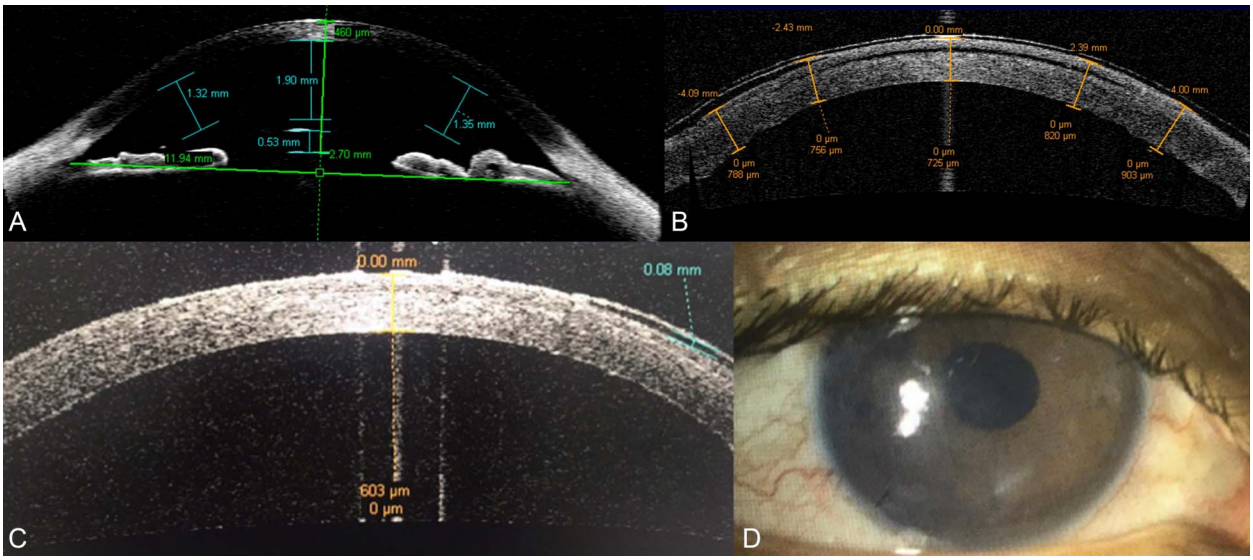


**FIGURE 1.** A, Pre-DMEK AS-OCT showing no IFS. B, AS OCT after DMEK showing IFS. C, One week after flap lifting with no IFS. D, Clear cornea at slit-lamp examination after IFS resolution.

drainage). In all cases, the flap was lifted, fluid was drained, and the flap was repositioned. Sutures were required to fixate the flap in the correct position in 2 cases (one because an unstable flap during the flap repositioning was observed, and the other to ensure IFS does not reappear for the third time).

## Postoperative Outcomes After IFS Drainage

Total resolution of IFS was achieved at 14.5 days (range 4–30 days) after DMEK. The mean BCVA after fluid drainage was 0.44 ± 0.31 and mean central corneal thickness decreased to 538 µm ± 160. Postoperative AS-OCT reveals a DMEK graft attached in all cases except for 1 patient, in whom second DMEK was performed due to DMEK failure (graft detachment after fluid drainage).

## DISCUSSION

LASIK flap IFS was first described by Lyle and Jin.[14] Although a rise in IOP may be the main mechanism,[4–9] IFS may occur in eyes with corneal endothelial cell failure without high IOP.[10,11] Luceri et al[11] reported a case with IFS stage 3 after phacoemulsification in a post-LASIK eye with preexisting Fuchs endothelial dystrophy that was reversed by DMEK, and

**TABLE 2.** Visual Acuity and AS-OCT Findings Before and After Fluid Interface Syndrome Resolution

| Case | BCVA at IFS Presentation (LogMAR) | BCVA After IFS Resolution | CCT (µm) at IFS Presentation | LASIK Flap Thickness at IFS Presentation (µm) | Thickness of the Fluid Interface (µm) |
|---|---|---|---|---|---|
| 1 | 0.70 | 0.18 | 1006 | 130 | 170 |
| 2 | 1.60 | 0.30 | 866 | 205 | 100 |
| 3 | 1.60 | 0.60 | 572 | 201 | 66 |
| 4 | 1.30 | 0.30 | 830 | 148 | 70 |
| 5 | 2.0 | 1.0 | 752 | 147 | 123 |
| 6 | 1.30 | 0.30 | 635 | 135 | 92 |

| Case | CCT After IFS Resolution (µm) | IOP at IFS Presentation (mm Hg) | IOP After IFS Resolution (mm Hg) | Final Resolution of IFS | Graft Attachment After IFS Resolution | Time for Total Resolution of IFS After DMEK | Last Follow-Up (months) |
|---|---|---|---|---|---|---|---|
| 1 | 544 | 14 | 15 | Total | Partial | 9 days | 1 |
| 2 | 653 | 17 | 14 | Total | Total | 4 days | 3 |
| 3 | 342 | 16 | 17 | Total | Partial | 15 days | 3 |
| 4 | 603 | 18 | 16 | Total | Total | 30 days | 3 |
| 5 | 731 | 14 | 14 | Partial | Partial | 30 days | 3 |
| 6 | 353 | 16 | 16 | Total | Total | 14 days | 3 |

BCVA, best corrected visual acuity; CCT, central corneal thickness; IFS, interface fluid syndrome; IOP, intraocular pressure; LASIK, laser in situ keratomileusis.

Moura-Coelho et al[10] reported a case of DMEK for the management of post-LASIK IFS secondary to a failed Descemet stripping automated endothelial keratoplasty graft.

Considering the clinical history of our patients, it is very probable that all these patients in their early life had a normal cornea because they underwent elective LASIK, and because of additional surgery (phacoemulsification or pIOL), endothelial decompensation occurred leading to the requirement of DMEK. Hence, our patients had endothelial failure which led to corneal decompensation; however, it seems that this corneal failure was not enough to develop IFS because all our patients had a normal AS-OCT finding and no IFS before DMEK and that DMEK was the trigger for the appearance of IFS. Figure 1 shows a case where no IFS was observed at preoperative evaluation; however, 30 days after DMEK IFS was developed.

In these case series, the pathogenesis of IFS after DMEK may be related to the function and/or manipulation of the new endothelium itself and not to the previous endothelial failure. After the donor graft is placed in DMEK, the new endothelium should reestablish the fluid regulation in the corneal stroma and maintain the endothelial ion transport system after the procedure. The manipulation of donor endothelium and/or the air/gas bubble at the end of the procedure could be involved in the delayed restitution of the endothelial ion transport. What happens in these post-DMEK patients could be in accordance with what happens in post-LASIK corneas taken from eye bank, in which a lamellar fluid interface occurs after 3 hours of corneal endothelial pump dysfunction.[15]

Our study has some limitations. The IOP readings should have been obtained over the peripheral cornea outside of the LASIK flap using a Tonopen or iCare. In our cases series, IOP was measured with a Goldmann tonometer at the center of the cornea and using digital pressure. IOP at the time of IFS was normal in all cases. Nevertheless, the authors decided to give hypotensive treatment based on the fact that the measurement of the IOP in these patients can be inaccurate[16] and because the main cause of this syndrome is high IOP. However, only 1 patient had a complete resolution of IFS with conservative hypotensive treatment suggesting that a cause other than IOP could be involved. Second, we do not apply another treatment as an alternative for the resolution of IFS, such as Rho kinase inhibitors[17] and venting incisions to all patients. In the first case that presented to our institution (after conservative management was not enough to resolve IFS), a venting incision was performed with no success, and based on this limited experience, the authors decided to manage future cases with flap lifting and not with a venting incision. Rho kinase inhibitors could be another alternative because they not only can reduce IOP but also help with endothelial restitution/migration; however, this molecule was not available in our setting.

Because of the high prevalence of post-LASIK corneas[12] and the growing popularity of DMEK, it is likely that we will encounter more cases of post-DMEK IFS in the future. Therefore, the authors recommend performing AS-OCT to monitor the endothelial attachment and the flap interface in patients undergoing DMEK with a history of LASIK in the early postoperative period.

In conclusion, post-DMEK IFS in patients with LASIK does occur. We recommend performing preoperative and early postoperative AS-OCT to monitor the flap interface in patients undergoing DMEK who have a history of previous LASIK. Early surgical intervention seems to be the most effective alternative for the management of these cases.

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