Difficult and Complicated Cases in Refractive Surgery

Use of Excimer Laser Surgery for Monovision in Cases of Unsatisfactory Outcome Following Cataract Surgery

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Jaime Javaloy and Alessandro Abbouda

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Why Is This Case Relevant for the Refractive Surgeon?

Monovision is the adjustment of one eye for near vision and the other for distance vision. Pseudophakic monovision is a type of monovision used in lens surgery to correct postoperative presbyopia by programmed refractive error from biometry calculations [1].

In this case we decided to correct the patient for far distance, but after 1 year the patient decided to try monovision.

Case Background

A 48-year-old woman came to our department interested in refractive surgery and complaining about the refractive change in her RE. Her manifest refraction was −7 in the right eye (RE) and −5.75 −0.75 × 70 in the left eye (LE). Her best corrected visual acuity (BCVA) was 20/20 for distance and near vision in both eyes (adding a lens of +2). Both slit lamp and fundus examinations were normal. According to the topography, her cornea surface was regular. According to LOCS III classification [2], a nuclear (N01) and cortical (C1) cataract was diagnosed. The patient used to drive during the night, so we avoided implantation of a multifocal IOL. Cataract surgery was performed with implantation of Alcon Acrysof MA60 +17 Diopter (Δ) in the RE and +16.5Δ in the LE. The postoperative was

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uneventful. After 6 months, her manifest refraction was −1.5 −0.75 × 145 in the right eye (RE) and −1 in the left eye (LE). Her uncorrected visual acuity for distance was 20/50 in the RE and 20/25 in the LE and for near vision was 20/40 in the RE and 20/32 in the LE. The topography showed a regular surface. The pachymetry was 482 µm in the RE and 489 µm in the LE. Keratometric index was 44.59/44.87 × 101° in the RE and 43.99/44.85 × 86° in the LE. The axial eye length measurement using the Zeiss IOL Master was 25.13 in the RE and 24.84 in the LE.

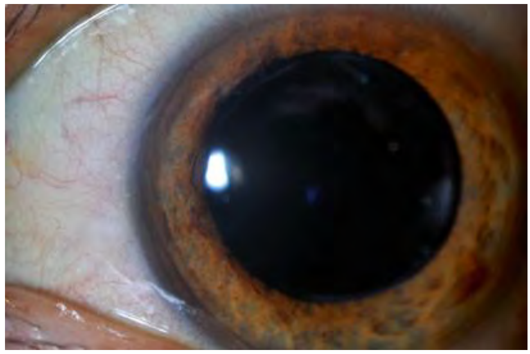

Fig. 17.1 Slit-lamp examination showed pseudophakic eye with a previous flap

Main Problem to Solve

The patient presents a thin cornea. The amount of ablation was 20.34 µm. The cutting of the flap was set at 90 µm.

Ancillary Tests

It is important to define the dominant eye and the posttest tolerance and adaptation of monovision with a contact lens [3]. In this case, the right eye was dominant.

Surgical/Medical Intervention

LASIK treatment was performed. Flap creation was performed using the Alcon Wavelight® FS200 femtosecond laser and corneal stromal ablation by the Alcon Allegretto® excimer laser.

Outcome

After 6 months, the patient's manifest refraction was −1.5 −0.75 × 145 in the right eye (RE) and plano in the left eye (LE). Her uncorrected visual acuity was 20/50 (RE) and 20/20 (LE) for distance and 20/20 (RE) and 20/30 (LE) for near vision (Fig. 17.1).

What to Learn from This Case

Pseudophakic monovision is an effective approach to manage loss of accommodation following cataract surgery, especially for a patient who wants to be free from glasses while the implantation of a MFIOL it is not possible. The preoperative refractive status of the patient should not determine which eye should be corrected. Rather, a full exam determining the sensorial and motor dominance is necessary to avoid mistaking the effect that an incipient cataract or even a different refractive status of the patient during his infancy might provoke. In our case, both eyes had similar features of axial length and keratometry, but had a different refraction (more myopic in the dominant RE before cataract surgery). A bilateral refractive treatment after cataract surgery can promote good near and distance vision, but only with correction of the dominant eye.

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Error in the Excimer Refractive Program: From a Simple Mistake to a Major Clinical Problem

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Why Is This Case Relevant for the Refractive Surgeon?

Every refractive surgeon should be very careful when typing or writing the refractive plan before surgery. Preventable human errors are one of the most common sources of sphere error after surgery [1]. Here we describe a case in which the transposed cylinder form was incorrect.

Case Background

A 36-year-old male was referred for refractive surgery. Cycloplegic refraction was $+2.25 = -2 \times 5°$ in the right eye (RE) and $+4.5 = -5.25 \times 170°$ in the left eye (LE), with the best spectacle-corrected visual acuity (BSCVA) of 20/20 in both eyes. The ultrasound pachymetry was 530 μm in both eyes. Keratometry indices were 41.36/43.15 × 98° in the RE and 39.7/44.34 × 78° in the LE. The topography showed a vertical bow tie according to astigmatism with rule in both eyes (Fig. 18.1). The flap creation was performed using Hansatome microkeratome and corneal stromal ablation by the Technolas 217z B&L® excimer laser. Three weeks post surgery, the patient was very worried. He complained of very bad vision in the LE. His visual acuity was 20/20 in the RE and finger count in the LE. The refraction of the patient was (RE) plano, and the LE improved to 20/40 with the refraction of $+7 = -10 \times 170°$.

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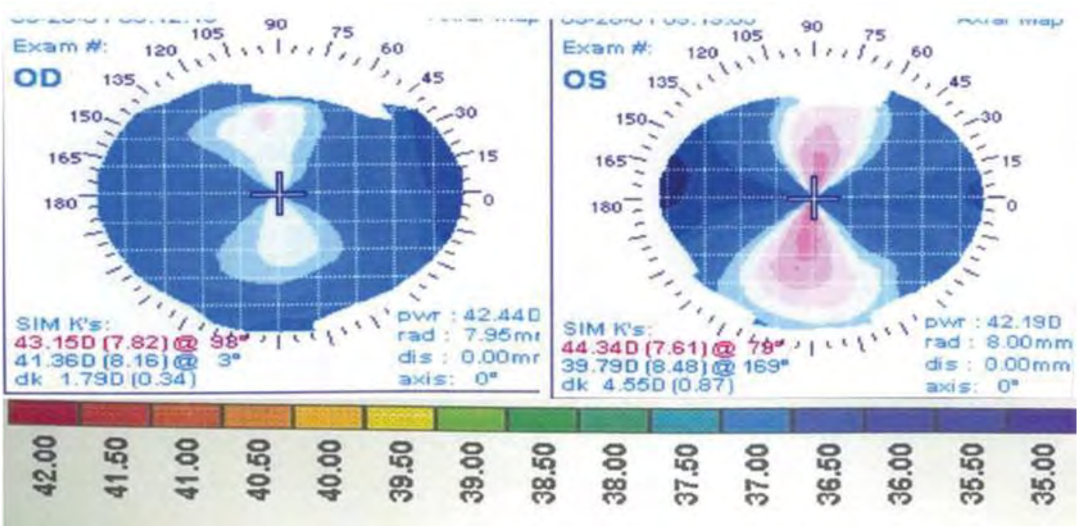

Fig. 18.1 Preoperative topography showed a vertical bow tie in both eyes according to astigmatism with rule

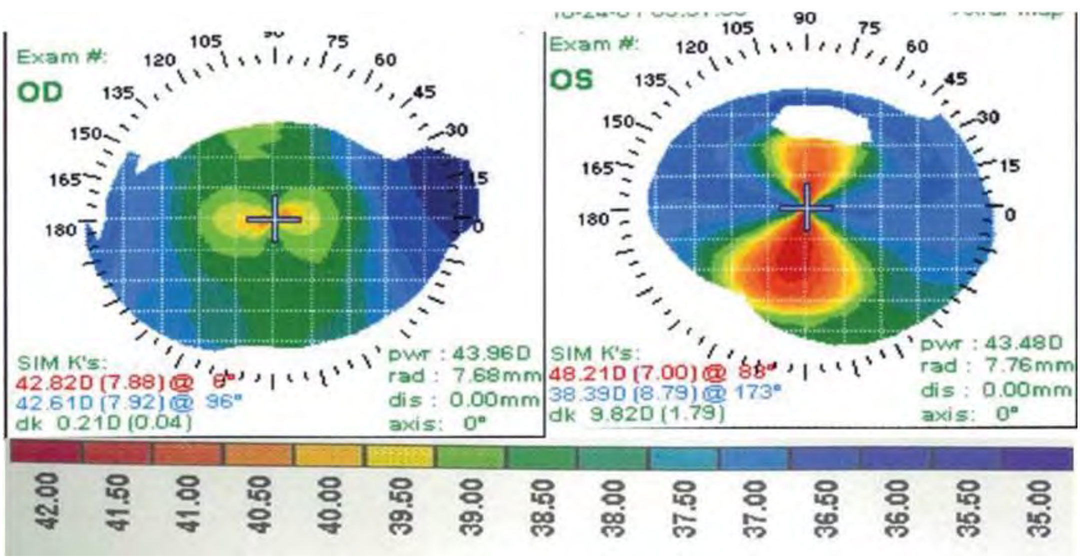

Fig. 18.2 Topography after the first treatment showed a horizontal bow tie in the RE and an increase of the vertical bow tie profile in the LE

The ultrasound central pachymetry was 514 μm in the RE and 480 μm in the LE. Keratometry indices were 42.6/42.8 × 6° in the RE and 38.3/48.2 × 88° in the LE. The topography showed a horizontal bow tie in the RE and an increase of the vertical bow tie profile in the LE (Fig. 18.2).

Main Problem to Solve

It was evident that some mistake had occurred. Upon analyzing the history, we realized that the transposed cylinder form was wrong. The refraction in the LE at the first visit was +4.5 = −5.25 × 170°, and in the surgery planning

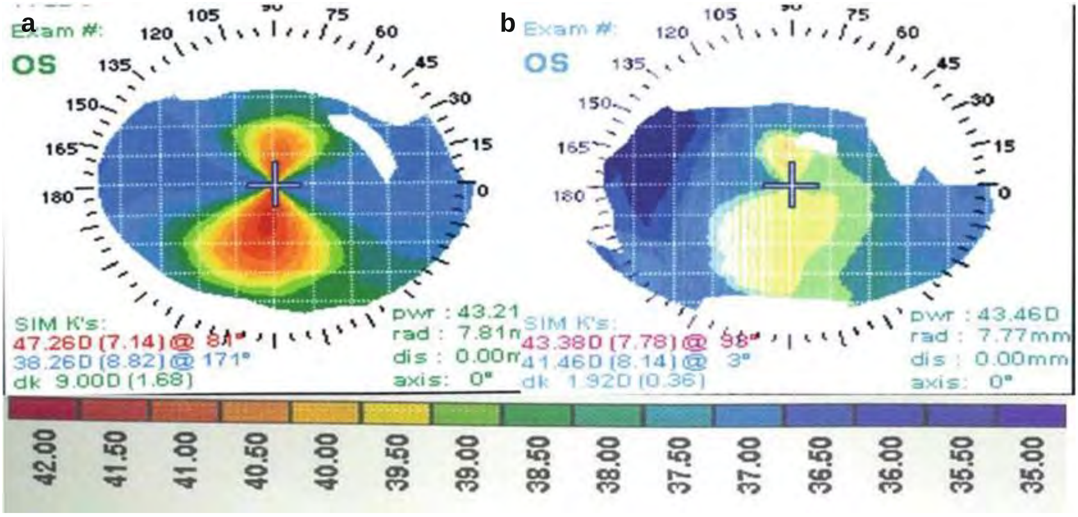

Fig. 18.3 (**a**) Left eye. Topography after 3 months of KTA showed astigmatism with rule. (**b**) Left eye. Topography after 3 months of LASIK re-treatment showed an irregular astigmatism with rule

it was −0.75 = +5.25 × 170°. The correct planning should have been −0.75 = +5.25 × 80°. The resultant refraction from this clinical mistake was finger count.

Ancillary Tests

Pachymetry was fundamental in this case. The previous laser did not waste a substantial amount of central corneal stroma because the profile applied was hypermetromic. This situation allowed us to follow a new laser ablation.

Surgical/Medical Intervention

The first approach was to reduce the high astigmatism. We chose to perform an arcuate relaxing incision (KTA). Two 80° opposite incisions were performed at 90 % depth at 7 mm of the center of the pupil on the LE. Both incisions of the arc were centered over the steeped axis at 80°. The second step, according to the residual refractive defect, was to perform a LASIK re-treatment over the remaining refractive defect after the incisional surgery.

Outcome

At 3 months post-KTA, the visual acuity in the LE was 20/25 with a manifest correction of 3 = −5 × 180°. The topography consistently showed a vertical bow tie. The keratometry index was 38.26/47.2 × 80° (Fig. 18.3a). On this refractive defect, the LASIK treatment was performed planning a crossed cylinder treatment. Three months after LASIK, the visual acuity in the LE was 20/25 without correction. The ultrasound central pachymetry was 430 μm in the LE. Keratometry indices in the LE were 41.46/43.38 × 98°. The topography showed an irregular vertical bow tie (Fig. 18.3b).

What to Learn from This Case

This case emphasizes the importance of carefully reviewing the refractive plan before surgery. The magnitude of this iatrogenic error was significant, and such a refractive surprise due to preventable transcription mistakes is possible for every surgeon. KTA was a good choice to reduce the astigmatism in this case, and the LASIK re-treatment resulted in a positive visual outcome.

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Buttonhole Flaps

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Why Are These Cases Relevant for the Refractive Surgeon?

Among intraoperative LASIK complications, the buttonhole flap is perhaps the most challenging. The buttonhole flap affects the visual axis and compromises visual, anatomical, and functional recovery, as well as has significant psychological and medicolegal repercussions. While free caps and incomplete flaps do not usually cause long-term loss of vision, the buttonhole formation is the most likely complication to result in glare and substantial loss of best corrected visual acuity (BSCVA). Management also poses therapeutic risks, including the formation of subepithelial stromal scars in the visual axis and the induction of irregular astigmatism.

In this section, we present three cases representing different stages or types of buttonhole flap complication, treatment approaches, and outcomes. In the first case, the complication is treated with delayed alcohol-assisted PRK, in the second case with a delayed laser-PTK-PRK procedure with an optimal anatomical result but a refractive hypercorrection, and in the third with an immediate PTK-PRK approach, which involves a long and slow evolution but has relatively positive results.

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Background

Case report 1: A 32-year-old white female with a manifest refraction of −2.5, −0.5 115° in the right eye (BSCVA 20/20, mean K = 44.25, central pachymetry of 548 μm) and −3.25, −0.75 × 15° in the left eye (BSCVA 20/20, K = 44.25, central pachymetry of 555 μm), and normal elevation topography was programmed for LASIK surgery. The surgeon used a manual microkeratome (Moria-LSK-ONE 100 μm footplate and −1 suction ring). LASIK in the right eye was uneventful, resulting in a nasal-hinged 80 μm flap. However, a complicated surgery in the left eye resulted in a buttonholed central triangular-shaped lesion with a small dot of epithelial ingrowth (Fig. 19.1). The flap was repositioned without laser treatment and a bandage contact lens was applied.

Case report 2: A 34-year-old white male with a manifest refraction of −5, −0.5 × 15° in the right eye (BSCVA 20/20, mean K=43.25, central pachymetry of 545 μm) and − 4.5, −0.25 × 145° in the left eye (BSCVA20/20, K = 43.25, central pachymetry of 546 μm), and normal elevation topography was programmed for LASIK surgery.

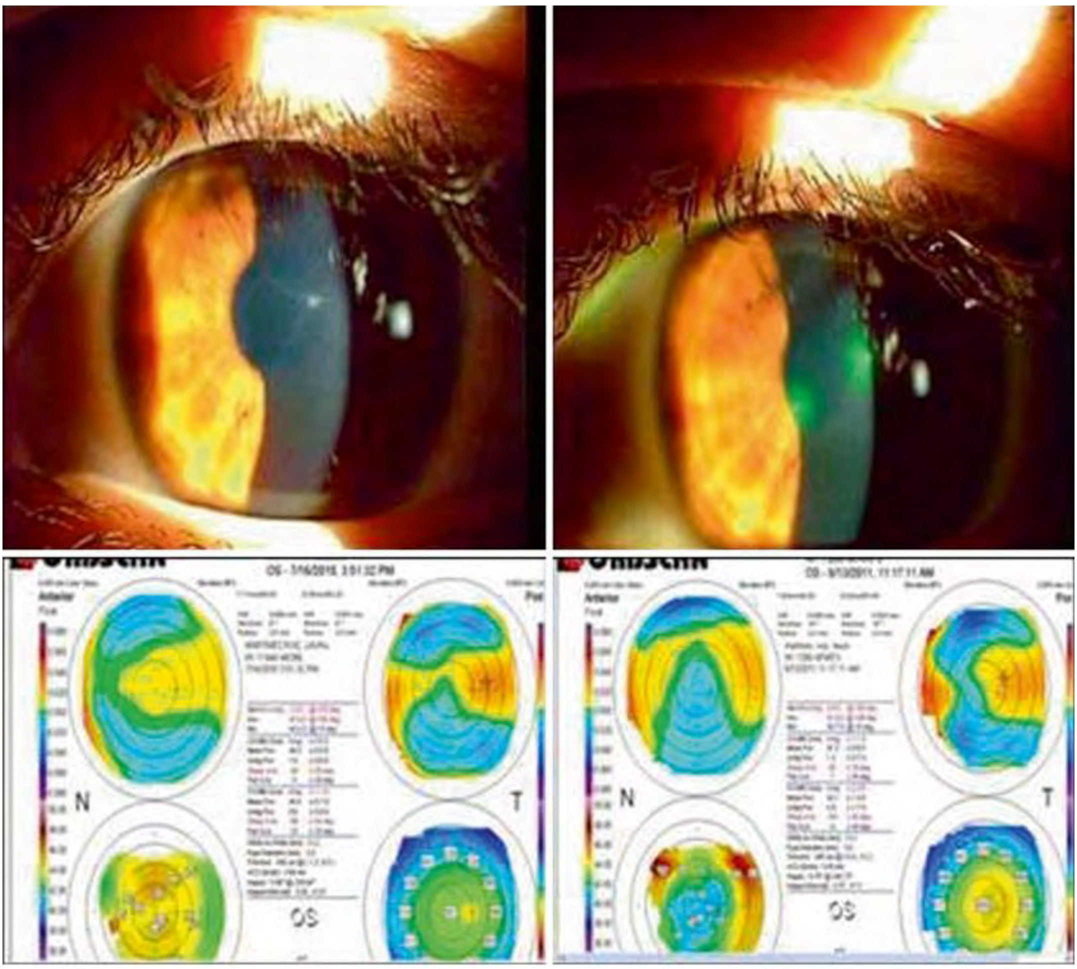

Fig. 19.1 Case 1. Buttonholed central triangular-shaped lesion with a small dot of epithelial ingrowing and natural evolution to a faint scar. Preoperative and postoperative topographies show a perfect recovery of the corneal surface and an optimal refractive outcome: UCVA = 20/20

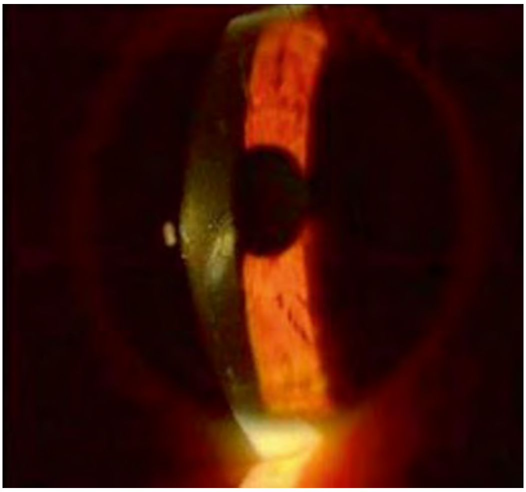

Fig. 19.2 Case 2. Paracentral inferior scar secondary to a buttonhole flap

The surgeon used a manual microkeratome (Moria-LSK-ONE, 100 μm footplate and −1 suction ring).

The microkeratome pass was apparently uneventful (OS), but a central buttonhole was noted once the flap was reflected. The flap was repositioned without laser treatment and a bandage contact lens was applied; the right eye was not operated on to prevent an anisometropia status (Fig. 19.2).

Case report 3: A 26-year-old male with no significant medical or ocular history elected to have LASIK for emmetropia. The preoperative refraction was −3.25, −0.5 × 15° in the right eye and −2.75, −0.5 × 185° in the left eye. In both eyes, the BSCVA was 20/20. Mean keratometry were 44.5 and 44.75 diopters (D) in OD and OS, respectively. Central ultrasonic pachymetry were 545 and 550 μm, respectively.

A corneal flap was attempted in the left eye using a Moria-LSK-ONE microkeratome with a 100 μm footplate and −1 suction ring. A buttonhole was noted centrally in the left eye when the flap was reflected, and a normal flap was created in the contralateral eye of 101 μm thickness. As the buttonhole was not manipulated and there was good apposition of the lesion edges, the surgeon decided to apply laser ablation in both eyes: standard LASIK in OD and in the left eye a PTK

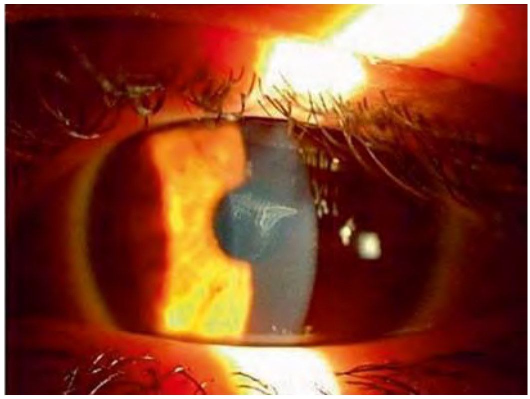

Fig. 19.3 Case 3. Central buttonhole scar with haze, epithelial ingrowth, and corneal irregularity

(50 μm, OZ = 7)/PRK/MMC. The OS in the immediate postoperative period progressed with a significant delay of reepithelialization lasting nearly 3 weeks, with redness and pain (Figs. 19.3 and 19.4).

Main Problems to Solve

The buttonhole is an intraoperative LASIK complication resulting from an uncut portion of the corneal flap which usually occurs at the central corneal apex. The formation may result in vision loss due to an irregular astigmatism and central scarring and/or epithelial ingrowth. Buttonholes occur during surgery when the blade misses an area in the cornea, leaving an uncut hole (Fig. 19.5); an island of tissue left remaining on the corneal bed fits like a puzzle piece into the hole. The microkeratome blade exits the epithelium prematurely as it travels across the stroma and quickly reenters to follow the original path.

The incidence of LASIK buttonholes (BH) varies from 0.20 and 0.56 % [1], with several theories accounting for their occurrence. Traditionally, steep corneas were reported to be at greater risk for this complication; however, Albelda-Valles et al. [2] found no relationship between steep keratometry and buttonhole occurrence in a study of 34,099 eyes. Other proposed explanations include malfunctioning of the microkeratome motor, inadequate suction

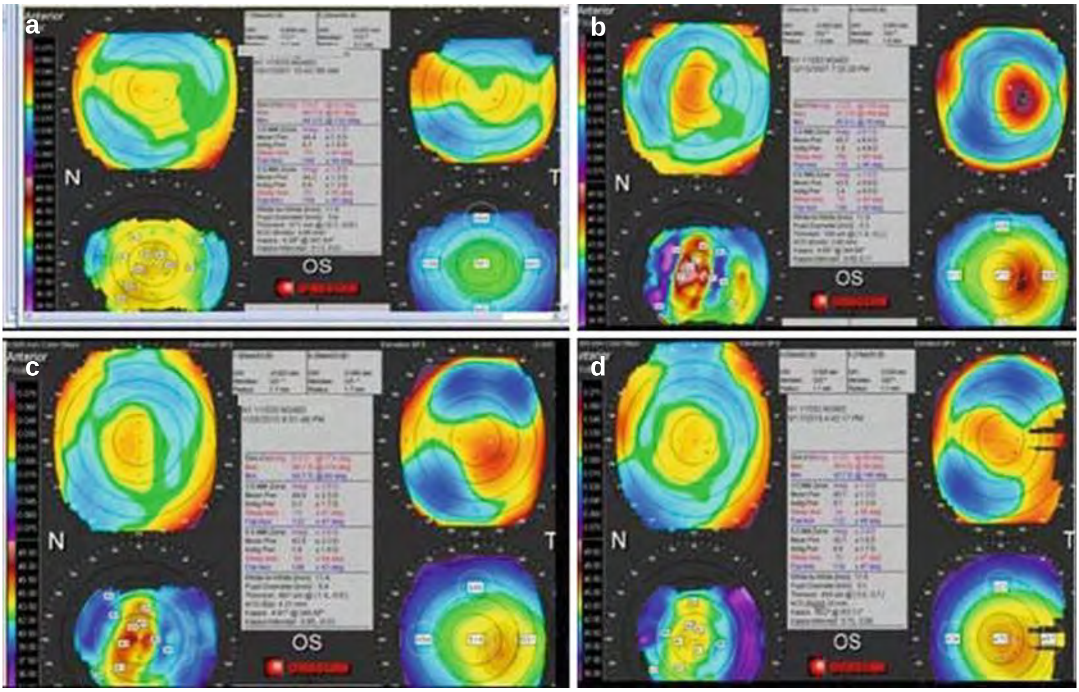

Fig. 19.4 Case 3. Topographic sequence: (**a**) preoperatively, (**b**) after first PRK/PTK, (**c**) after 1 year natural evolution, (**d**) after second treatment (PRK/PTK topo-guided)

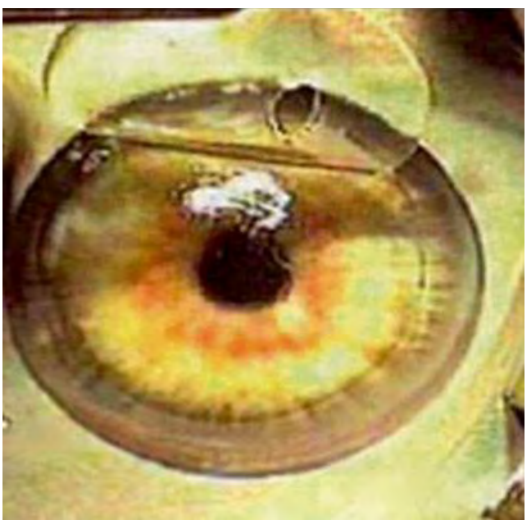

Fig. 19.5 Central buttonhole flap following the microkeratome pass (Taken from Randleman et al. [6]. Online course, American Academy of Ophthalmology)

(malfunctioning of vacuum unit or other etiologies that compromise the adherence of the suction ring to the cornea such as high astigmatism, conjunctival incarceration, etc.), and even poor quality of the blade [3].

Once a buttonhole occurs, we propose the following steps:

1. Ensure the best anatomical reposition.
2. Decide whether to cancel the procedure or perform an immediate laser treatment.
3. Avoid associated inflammatory complications.
4. Decide timing of re-treatment.
5. Decide on another re-treatment technique.
6. Treat severe anatomical complications.

Ancillary Tests

Harissi-Dagher [1] and coauthors reported a useful classification of buttonholes in three stages based on the development of epithelial ingrowth which determined a practical management approach: stage 1 (a full- or partial-thickness buttonhole without epithelial ingrowth), stage 2 (a full- or partial-thickness buttonhole with epithelial ingrowth), and stage 3 (a full- or partial-thickness buttonhole

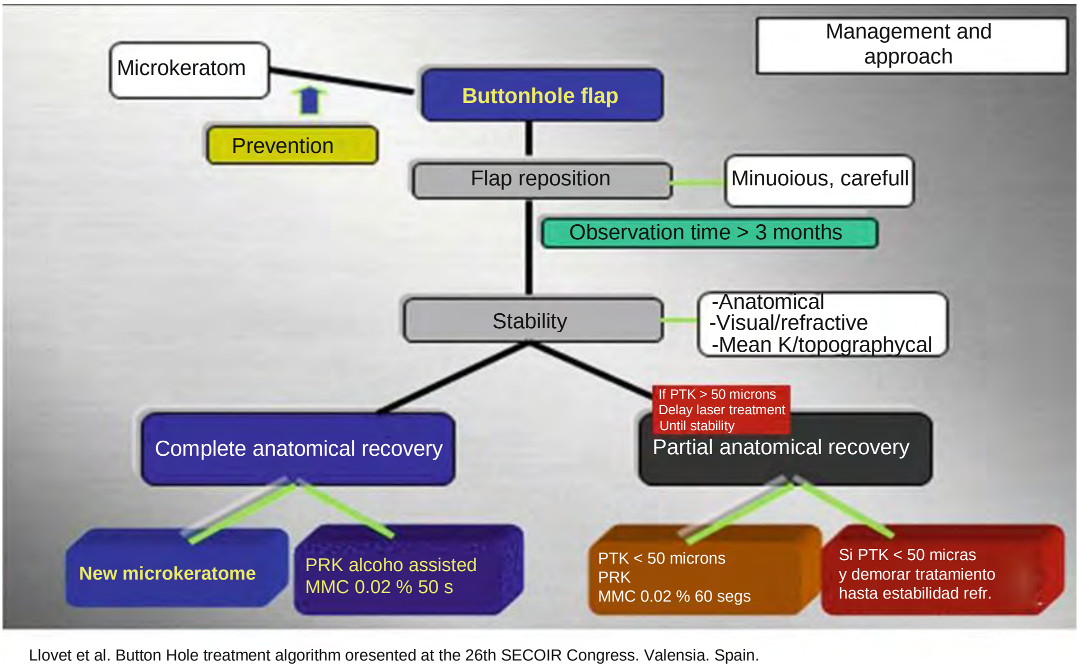

Fig. 19.6 Algorithm decision in a buttonhole flap complication (Llovet et al. [7])

with epithelial ingrowth and resultant stromal melt/scarring or flap elevation).

Creation of a new LASIK flap beneath the buttonhole flap by means of a new microkeratome pass is another option in cases of good anatomical recovery without significant leukoma in the visual axis. Figure 19.6 shows our own decision-making algorithm regarding management and surgical approaches according to various levels of severity and complication.

Surgical/Medical Intervention

1. Ensure the best anatomical reposition. A meticulous intraoperative repositioning of the flap is extremely important to ensure good apposition of the buttonhole margins and to avoid irregular astigmatism and infiltration of the epithelial cells through the buttonhole edges, which would cause epithelial ingrowth. Although it is not always easy to reposition these flaps, it is important to be careful during this step and to take as long as necessary to align the edges of the disk correctly to achieve a correct reattachment.
2. Cancel the procedure. The most accepted response to buttonholes is to cancel the procedure and bypass treatment with laser, which can induce an irreversible irregular astigmatism. Although immediate (same day) surface ablation (PTK/PRK) has been reported [4] with initial success, the series was limited by a short-term follow-up. Concern regarding imme- diate treatment includes the possibility of acti- vated stromal keratocytes creating scar tissue or a delay of reepithelialization and a corneal ulcer complicating the situation. Although prophylactic MMC may limit the development of scar tissue after immediate treatment, the rationale for delaying treatment by several weeks pertains to the surface epithelium as well as significant medicolegal issues of informed consent.
3. To avoid associated inflammatory complications, maintaining a postoperative steroid treatment for several months is important to avoid further complications such as DLK and to minimize further corneal scarring.

4. Decide on the timing of re-treatment. Usually the surgeon and patient are motivated to address the complication early in the postoperative period. However, a postoperative waiting period of at least 3 months is recommended in order to allow the cornea to heal and restore to its original refraction. Patients usually become anxious and demand an earlier re-treatment, especially if an anisometropia status has been created. Therefore, proper counseling as to the advantages of waiting (e.g., less haze, better surface regularity from epithelial remodeling) and postponing re-treatment lead to better results.
5. Re-treatment technique: Although a new, deeper flap can be created by repeating a microkeratome pass below the original flap, the safest way to manage buttonholes is to treat them with surface PRK assisted with mitomycin C 0.02 % for 60 s [5].
   Deciding between alcohol-PRK and laser-PTK-PRK, epithelial removal techniques depend on the epithelium conditions and topographic abnormalities. The most accepted transepithelial PTK ablation is 50 μm and for PRK should be readjusted to 80 % of subjective refraction. In the series reported by Harissi-Dagher, overcorrection occurred in 33 % of the PTK-PRK cases [1].
6. Treatment of severe anatomical complications. In cases of progressive epithelial ingrowth, a two-stage treatment is recommended. First, PTK applied therapeutically obliterates infiltrated epithelial cells and recovers as much transparency as possible. Second, a PRK procedure of residual refraction is called for, which can be modified by the PTK procedure.
   Cases of irregular astigmatism or significant scarring should also be treated in two stages, PTK followed by topographically guided ablations (Fig. 19.6).

Outcomes

Case 1: One month after initial surgery, there was a very faint line scar (Fig. 19.1). Three months later, BCVA recovered to 20/20 with sph −3.25 cyl −0.5 axis 15° ($K = 43.75$, keratometric cylinder of −0.75 D, axis 30°), and the buttonhole was no longer visible at the slit lamp. Re-treatment was performed by means of alcohol-assisted PRK (20 % alcohol during 40 s plus mitomycin C and a bandage contact lens 8.8). Postoperative evolution was favorable, achieving a prompt complete transparent epithelialization at 1 week post-PRK, a final UCVA of 20/20, an emmetropia status ($K = 41.25$), and a normal topography (Fig. 19.1).

Case 2: Two months after initial surgery, there was still a central scar with epithelial ingrowth, significant haze, and loss of BCVA (20/40) with sph – 5.0 D ($K = 43$ keratometric cylinder of −1.75 D, axis 68°) (Fig. 19.2). Finally, 6 months after initial surgery and stabilization of refraction and topographies, we decided to perform the treatment in both eyes: PRK in OD and a PTK/PRK/MMC procedure (70 μm), optical zone of 7 plus a PRK (−5.0 D) in OS. Postoperative evolution showed a favorable anatomical outcome, achieving complete transparency of the cornea and resolution of the haze and the scar in OS. Unfortunately, however, the functional result was suboptimal, developing an overcorrection with a final refraction of +1.5 D. Refraction at 10 months postoperatively was OD (UCVA = 20/20, +0.25 sph, mean K of 39 D) and OS (UCVA = 20/30, BCVA with +1.5 sph = 20/20, mean K of 38 D). As the patient did not tolerate the postoperative anisometropia, we recommended a hyperopic PRK re-treatment; however, the patient decided against it, and we lost follow-up contact.

Case 3: Over the 4 months following the procedure, the follow-up showed a corneal central scar with haze and epithelial ingrowth OS (Fig. 19.3) that derived in a myopic shift with irregular astigmatism and significant loss of BCVA. One month postoperatively, refraction in OD was emmetropia with UCVA of 20/20. In OS, UCVA was 20/200, refraction was −3.25, −4.5 × 57° (K=47.75), and BCVA=20/60.

Intensive steroid treatment applied over several months resulted in gradual restoration of the corneal surface and more regularity within the refraction and topographies. (Fig. 19.4 shows topographic sequence.) Eight months postoperatively the patient was very uncomfortable with the anisometropia, and a rigid contact lens had to be applied achieving a BCVA=20/30.

One year post-op, the patient consented to a new PTK/MMC topographically guided by the Allegretto excimer laser system. PTK was 50 μm depth and OZ = 7 mm followed by a PRK programed with −1.0 D (28.9 μm of maximum depth). Finally, after the second re-treatment, the cornea achieved a transparency, a very light residual haze, a regular topographic appearance (Fig. 19.4) with a refraction of −2, −0.5 75°, and a BCVA of 20/20. A phakic intraocular lens (ICL) was recommended but the patient refused it at the moment.

What to Learn from These Cases

These cases demonstrate that the best approach to buttonhole flap formation is to cancel the laser treatment and proceed when the best spectacle-corrected visual acuity approaches the preoperative level or has stabilized. Secondly, if the flap allows an alcohol-assisted PRK, the laser refractive treatment will be more predictable. If choosing a PTK-PRK technique, it is very important to calculate both ablations in order not to induce hypercorrection. In Case 1, we obtained a better result with alcohol de-epithelialization, as the posterior refraction treatment by PRK is reliable and easily reproducible. However, in Case 2 we miscalculated the PRK/PTK ablation, leading to overcorrection and a hyperopic shift. In severe cases such as Case 3, more than one procedure separated by months may be required to eliminate the central cut or doughnut-shaped flap scar.

Although buttonhole flap formations are a potentially serious complication of LASIK, a planned, delayed reoperation after sufficient corneal healing that employs the proper technique can allow satisfactory recovery of UCVA and BCVA.

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Dislocated Flaps

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Why Is This Case Relevant for the Refractive Surgeon?

A dislocated flap is a mild complication of LASIK, ordinarily detected promptly (in less than 24 h) and managed easily, resulting in a favorable anatomic and functional outcome. The precise cause of flap dislocation is unclear, but wrinkling or dislodgment may result from poor adherence of the corneal flap to the stromal bed because of overhydration of the stromal bed or the flap, eye rubbing, excessive blinking, and eye squeezing from pain, photophobia, or other discomfort in the postoperative period. Although flap dislocation is a relatively rare complication of LASIK (incidences range from 0.012 to 5.8 %) when a flap remains wrinkled for several hours or overnight, visual recovery is delayed because of apposition and incongruous fitting between the edematous folded flap and the bed, despite prompt surgical repositioning. In these situations, refractive regression is often indicated, which requires an enhancement treatment and mild persistent microstriae that can affect quality of vision. In addition, severe cases of permanent wrinkles or an irregularly shaped corneal surface can lead to diminished UCVA and BCVA, additional surgical maneuvers, or even flap amputation.

Included in this chapter are the results of a descriptive study of dislocated flaps we have encountered in our practice. We highlight a case of prompt diagnosis and successful intervention with a favorable response and outcome.

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Case Background

A 50-year-old white female with a manifest refraction of −8, −0.5 × 10° in the right eye (BSCVA, 20/25) and −5, −0.5 × 174° in the left eye (BSCVA, 20/20) underwent uneventful bilateral simultaneous LASIK for the correction of myopia and astigmatism. Mean keratometry was 42.25, −1 × 176° OD and 42.5, −0.75 × 174° OS; preoperative pachymetry 568- and 565-μm OD/OS, respectively; normal topographies and Orbscan white-to-white distance 11.8-mm OU; biomicroscopic clear lenses; and myopic fundus without peripheral rhegmatogenous retinal lesions.

LASIK surgery was performed using a manual microkeratome (Moria LSK-ONE), 9-mm H-suction ring diameter and a 10-μm-thickness footplate without complications, creating nasal-hinged flaps of 125- and 80-μm thickness in OD and OS, respectively. The excimer laser (Technolas Zyoptix) performed ablation depths of 115 μm (optical zone OZ = 6.0) and 80 μm (OZ = 6.2) in OD and OS, respectively, aiming at monovision OD. An Alphagan® drop was instilled postoperatively in both eyes in order to minimize hyperemia and discomfort, and no eye shield was recommended. Twenty-four hours after surgery, the patient came to the office complaining of moderate discomfort, redness, and worse vision in the right eye. Apparently there was no history of eye rubbing, but the patient admitted that application of lubricant tear drops was not asymptomatic and painless (despite printed instructions).

Slit lamp examination revealed an edematous partially inferior dislodged corneal flap in OD with flap folds across the visual axis and an exposed area of temporal stroma (Fig. 21.1). The patient's flap was immediately stabilized in the slit lamp at the office, a bandage contact lens was applied, and the patient was sent to the surgery room to complete the flap-folding treatment.

In the surgery room, the flap was repositioned with the following technique:

- Hydration of the stroma and flap with hypotonic solution (destillate water) and physiologic 0.9 % saline.

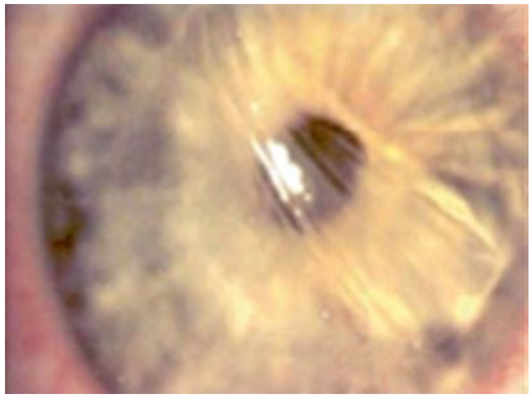

Fig. 21.1 Flap inferonasal dislocation with deep folds affecting visual axis of the RE

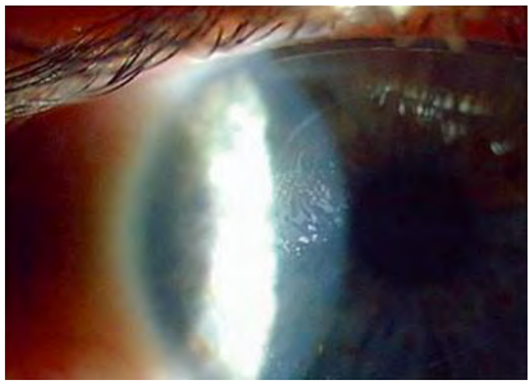

Fig. 21.2 Postoperative white-dot patches of epithelial ingrowth after flap reposition technique with epithelial removal

- Lifting, repositioning, and flap stretching and drying of the flap cornea ring junction.
- Central epithelial removal was performed due to persistent deep striae beside de hinge despite a correct flap edge alignment.
- Placing of a bandage contact lens and cycloplegic plus dexamethasone-tobramycin drops.

Postoperatively, the eye developed a central area of small white dots of epithelial ingrowth (Fig. 21.2) after reepithelialization healing. A mild diffuse lamellar keratitis resolved with intensive topical dexamethasone-tobramycin drops in 6 weeks, leaving a clear, wrinkle-free cornea. Three months later, the BSDCVA was 20/20 (−1.25, −0.5 × 180°) and the UCNVA was J3.

Main Problem to Solve

The primary problem is avoiding corneal fixed folds at the visual axis that produce an incongruent fitting of the flap and bed surfaces and which cause visual loss, haze, and refractive regression. Less frequent complications include epithelial ingrowth, stromal interface inflammation (DLK), infection, and recurrent shifting, which in severe cases can lead to lysis and necrosis of the flap, even requiring amputation to recover media transparency.

Ancillary Tests

Although this case has a clear surgical indication, sometimes the flap displacement can be mild with light striae out of the visual axis, requiring repositioning with the slit lamp. Some additional challenges for the refractive surgeon may include interpretation of the severity of striae, determination of its visual repercussion, deciding to work under the microscope in the surgery room (with the subsequent increase of patient anxiety), or cases requiring surgical stretching. Table 21.1 offers a decision algorithm for use in encountering some challenges.

Surgical/Medical Intervention

The repositioning described techniques are as follows:

- Lifting, hydration (refloating) of the flap with hyposmotic solutions, stretching it with blunt forceps and/or microsponges, and meticulous dryness of flap edge. This is the most extended technique, and it often takes a long time to obtain a good reposition.
- If folds persist after flap reposition and a correct alignment of the border (Fig. 21.3), central de-epithelialization can release mechanical tension and facilitate corneal stretching.
- Other fold-treatment techniques described are:
  - Llovet's rolling technique: ironing and pressing the folds using a heavy syringe filled with saline solution and performing a perpendicular movement to the folds direction (presented at the 82nd Congress of Spanish Society of Ophthalmology, Sept. 2006) (Fig. 21.4)

Table 21.1 Techniques for repositioning the LASIK flap

Slit lamp	Operating/laser room
Debridement; small amount	Debridement; large amount
Striae	Striae with sutures
Displaced flap	Epithelial ingrowth
	Infection; need for culture
	Irrigation of diffuse lamellar keratitis

Taken from Lichter et al. [1]

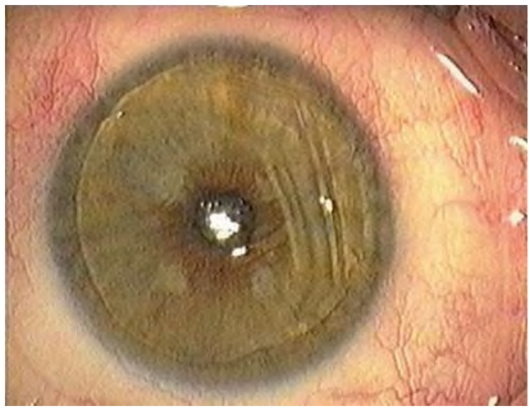

Fig. 21.3 Persistent deep flap striae beside the nasal hinge despite a correct flap edge alignment

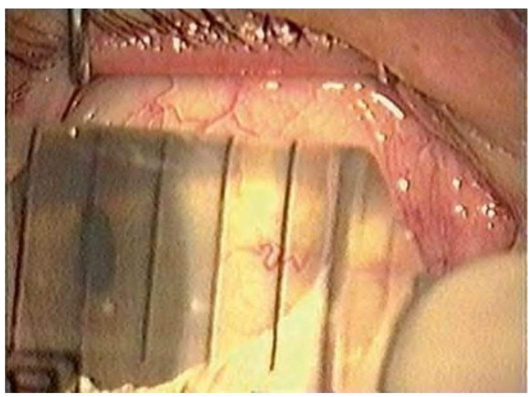

Fig. 21.4 Llovet's rolling technique fold treatment: ironing and pressing the folds using a heavy syringe filled with saline solution performed at a perpendicular movement to the striae direction

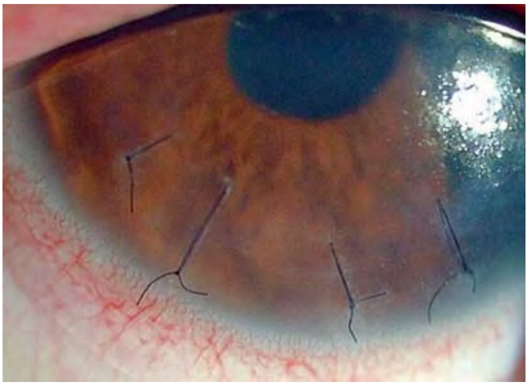

Fig. 21.5 Flap suturing (four 10-0 nylon stitches) in a refractory case (a 28-year-old male) with recurrent dislocations (three times), peripheral haze, and stromal edema

  - Donnenfeld hyperthermic treatment of the flap with a hot spatula (JCRS 2004)
  - Sandwich technique (Hernandez-Matamoros and Iradier, JCRS 2001)
- Sutures: Usually there is no need to suture the flap, but in cases of deep persistent folds after previously mentioned surgical maneuvers or repeated dislocations, flap suture with 10-0 nylon is sometimes necessary to maintain equal tension by pulling at opposite sides of the wrinkles (continuous or separated stitches) (Fig. 21.5).
- In cases of long-lasting flap dislocation with the suspicion of growing epithelium over bare stroma, removal and scraping of the epithelial cells with a knife, spatula, or both over the posterior surface of the flap and the bed are recommended.
- Finally, placing a bandage contact lens can stabilize the flap and reduce the risk of epithelial ingrowth.
- Prophylactic antibiotics, corticosteroids, intensive lubricant artificial drops, and in some cases cycloplegics are the treatments of choice to prevent further infectious and inflammatory complications.

Immediately following the repositioning procedure, the appearance of the flap worsens due to edema of the epithelium and stroma, with the folds initially becoming more evident and opaque. Twelve to 24 h later, the striae tend to diminish, and the cornea becomes flatter and clearer.

Outcome of Dislocated Flaps

This case had a favorable outcome despite an immediate postoperative epithelial inflammation. Topical corticoid therapy was used to achieve positive anatomic and functional results.

Reports of follow-up of patients with subluxated flaps are scarce. Recep et al. [2] reported the outcomes at 6 months in 19 cases, which were compared with the contralateral uneventful eye. These cases showed slightly worsening visual and refractive results, although results were not statistically significant. Another more recent study by Clare et al. [3] evaluated the risks factors for early flap displacements (less than 48 h) using a logistic regression model of ten eyes over 12 months. The study showed an extremely low incidence of flap displacement (0.012 %) and a higher risk for mechanical microkeratome compared with IntraLase femtosecond flaps. It showed a statistically significant higher risk for hyperopic eyes (eight cases) than myopic eye (two cases), reporting an OR of 19.29 for hyperopia and 10.53 for mechanical microkeratomes.

We are conducting a retrospective analysis of our own series of dislocated flaps through the Clinica Baviera Group data base from 2002 till present. Our purpose is firstly to investigate the outcomes of these complicated eyes and secondly to ascertain if particular preoperative and/or intraoperative conditions influence flap dislocation. Out of 300,000 cases, 429 (or 0.1 %) involved this flap dislocation. We compared the functional postoperative results of the study with a control LASIK group to determine whether outcomes were significantly different. Publication is pending. Most cases we found showed early dislocations; 77 % of cases were detected in less than 24 h. One hundred and twenty-one clients experienced dislocation within the same day of surgery and 209 the day after surgery (Clinica Baviera has a 24-h emergency service). Only 13 cases involved traumatic dislocation 3 months post-surgery, with a single case 2.5 years post-surgery. Table 21.2 identifies myopia as the main refractive defect, present in 78 % of cases; of these, 19 % were cases of high myopia (SE < −6D). Hyperopia comprised only 22 % of dislocated

Table 21.2 Preoperative data of the series

N (6 eyes with dislocation after enhancement procedures)	*429*
Spherical equivalent (SE) (mean, SD)	−2.81 (3)
Cylinder (mean, SD)	−1.24 (1.2)
Myopia (%) (spherical myopia, simple and compound myopic astigmatism)	78 %
Hyperopia (%) (spherical hyperopia, simple, compound and mixed astigmatism)	22 %
Significant astigmatism (≥2D) (%) Keratometric cylinder	23.3 %
Mean K	43.7 (1.8)
BSCVA	0.9 (0.13)

Table 21.3 Functional postoperative data

	Cases	Control	
	N = 429 (%)	N = 165 (%)	P
Efficacy[a]	72.7	73.9	>0.05
Safety[b]	9.1	2.4	<0.01
Predictability[c] (+/− 0.5D)	73.6	88.2	<0.01
% Enhancement	9.3	3.9	<0.05

[a]Percentage of eyes with difference between postoperative uncorrected visual acuity and preoperative best-corrected visual acuity (BVCA) ≥ 0 Snellen lines
[b]Percentage of eyes with loss of ≥ 1 lines between preoperative and postoperative BCVAs
[c]Percentage of eyes with postoperative spherical equivalent of ±0.5 D

flap cases, and significant astigmatism (>2D) comprised 23 %. The distribution of refractive error is similar to that found in standard LASIK surgery, indicating no influence of specific refraction in the flap dislocation.

Our series had poorer postoperative outcomes compared with uneventful LASIK procedures, showing a statistically significant worse predictability, percentage of enhancement, and safety parameters despite early detection and prompt treatment (Table 21.3). The most frequent anatomic complications were epithelial ingrowth (principally peripheral and stable), different grades of haze, recurrent keratitis, dryness, and persistent striae.

What to Learn from This Case

Post-LASIK flap dislocation is an infrequent complication (0.1 % in our series). Although severe further complications can occur, they are exceptional and typically result in good anatomic and functional outcomes (77 % in our series) when promptly and appropriately managed. However, flap dislocation cases typically have a slow recovery when they involve poor flap-bed surfaces fitting and persistent microstriae, causing loss of BSCVA and poorer quality of vision.

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Epithelial Ingrowth: Use of Topography in the Management

48

Jaime Javaloy and Alessandro Abbouda

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Why Is This Case Relevant for the Refractive Surgeon?

Epithelial ingrowth at the edge of the flap is one of the most significant complications of LASIK. Reports of the incidence of epithelial ingrowth have ranged from 0 to 20 % [1–4]. It usually presents in the early postoperative period and is known to be associated with loose epithelium, epithelial defects at the time of surgery, hyperopic LASIK correction, enhancement surgeries, flap instability, and corneal epithelial basement membrane dystrophy [1, 3–5]. While not always serious, it can progress to induce irregular astigmatism or melting of the overlying flap and threaten the central vision.

Background of the Case

A 34-year-old woman with no ocular history presented for refractive surgery evaluation. Her manifest refraction was −1.5 in the right eye and −4.5 in the left eye. Her best corrected visual acuity (BCVA) was 20/20 for distance and near in both eyes. Both slit lamp and fundus examinations were normal. According to the topography, her cornea surface was regular, her right eye pachymetry was 534 μm, and her left eye pachymetry was 546 μm. She underwent an uneventful LASIK procedure, both eyes targeted for distance. Flap creation was performed using the IntraLase FS laser (IntraLase Corp) and

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corneal stromal ablation by the AMARIS SCHWIND excimer laser. The postoperative evaluation was normal. The slit lamp examination showed no anomalies, no epithelial defects at the flap edge, a clear interface, and a well-positioned flap.

At the 2-year follow-up, the patient complained of a reduced vision in her left eye. Her uncorrected visual acuity (UCVA) was 20/32. According to the topography, her cornea surface was regular, and her left eye pachymetry was 490 μm. She opted to receive a re-treatment. Her residual stroma was 320 μm.

After 4 months, the slit lamp examination showed an epithelial ingrowth near the margin of the pupil. The topography showed an initial sinking area. We decided her follow-up should be without re-treatment. After 3 months, she presented frank epithelial nests. The topography didn't change with respect to previous months (Fig. 48.1a).

After 6 months, she complained of a reduced vision in the left eye. Her UCVA was 20/60, and her corrected distance visual acuity (CDVA) was 20/20. The topography showed an increase in the defect area. The slit lamp showed a white stromal oval area of 3 × 4 mm with indistinct margins. The lesion was fluorescein negative (Fig. 48.1b).

Main Problem to Solve

In this case, there is evident interface opacity within the pupillary diameter, and the slit lamp examination and topography suggest the possibility of stromal melting. Close follow-up is recommended to be able to treat the patient with success as soon as we get all the clues leading to the right diagnosis. A topography can help in the management.

Ancillary Tests Necessary

A corneal topography could be helpful in the case of epithelial ingrowth to show the shift versus stromal melting. The progressive increasing of the lesion area suggested a fast removal of epithelial cells.

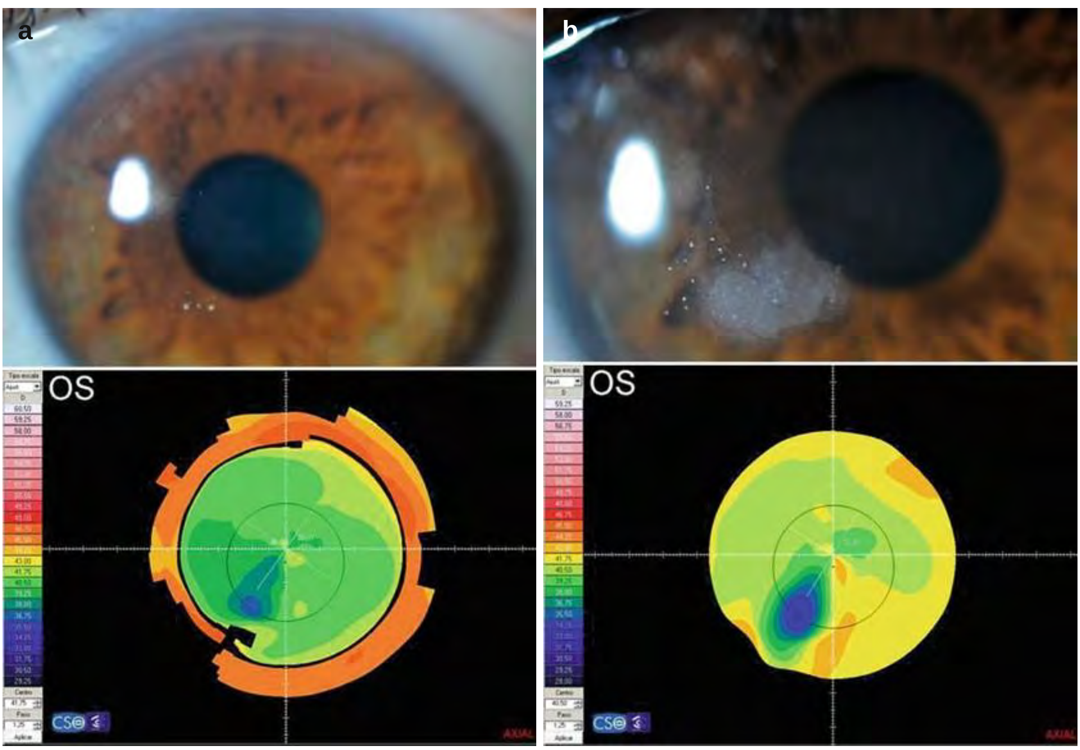

Fig. 48.1 These pictures show a topography and clinical aspect of epithelial ingrowth at the beginning (**a**) and before the re-treatment (**b**). (**c**) Shows clinical and topography resolution aspect

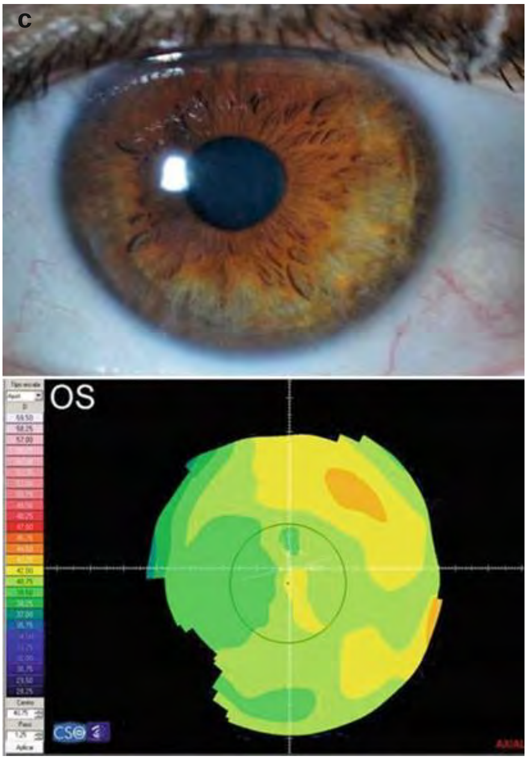

Fig. 48.1 (continued)

Surgical/Medical Intervention

The patient underwent a flap lift and scraping of the ingrowth material. A mechanical debridement of epithelial cells was performed on the back of the flap and on the surface of the residual stromal bed. All epithelial cells were removed, and the interface was irrigated with balance salt solution (BSS). The flap was repositioned and stitched with nylon 10.0.

Outcome

After 4 months postoperatively, the slit lamp examination showed a tender oval opacity with no epithelial cells with a well-positioned flap (Fig. 48.1c). In the left eye, the UCVA was 20/32, and the CDVA was 20/20.

What to Learn from This Case

Corneal topography is a sensitive test to alert us to a progression of epithelial ingrowth. In the topography the evolution towards flap melting due to collagenase release from necrotic epithelium appears as an increase of a flattening area. The patient may be asymptomatic. However, flap melts can lead to a distortion of the corneal surface with possible astigmatic changes.

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Other Complications: Abnormal Healing in Femtosecond LASIK

56

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Why Is This Case Relevant for the Refractive Surgeon?

Corneal wound healing is a complex process mediated by autocrine and paracrine interactions between cytokines, growth factors, and chemokines produced by epithelial, stromal, and immune cells, lacrimal gland, and corneal nerves [1].

The abnormal healing response may be attributable to an increased release of epithelium-derived cytokines, resulting in increased keratocyte apoptosis, keratocyte proliferation, and myofibroblast generation or basement membrane damage.

A refractive surgeon should be aware that when the thin flap is performed, keratocyte activation can occur.

Case Background

A 26-year-old woman with no ocular history presented for a refractive surgery evaluation. Her manifest refraction was −8.0, −0.50 × 90° in the right eye (RE) and −8.50, −0.50 × 115° in the left eye (LE). Keratometry readings were 47.46/47.46 × 180° in the RE and 47.51/47.51 × 180° in the LE. Her best corrected visual acuity (BCVA) was 20/20 for distance and near vision in both eyes. Slit-lamp and fundus examinations were normal. According to the topography, her cornea surface was regular. Her RE pachymetry was 573 μm and LE pachymetry was 576 μm.

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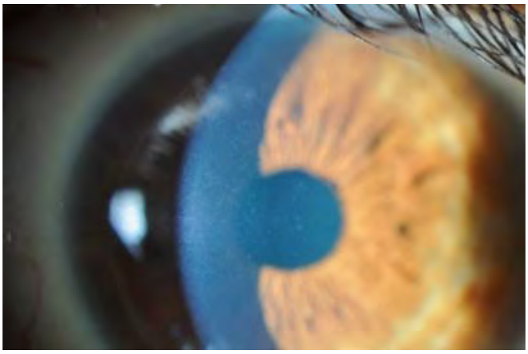

Fig. 56.1 Slit-lamp examination 1 week postoperative showed keratocyte activation

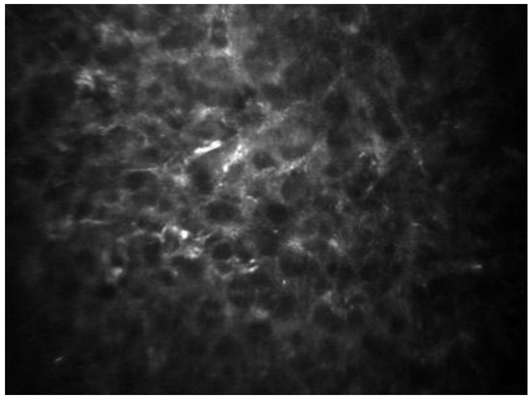

Fig. 56.2 Confocal microscopy shows increase in anterior stroma reflectivity

According to the pachymetry values and ablation depth, we decided to perform LASIK treatment with the flap setting at 100 μm. The patient started the following treatment: ofloxacin (5 times a day for 7 days) and dexamethasone 0.1 % (3 times a day for 7 days). One week after surgery, UCVA was 20/20 in both eyes. Slit-lamp examination showed a subtle white-dotted pattern located in the anterior third of the corneal stroma (Fig. 56.1).

Main Problem to Solve

Keratocyte activation induced by LASIK has a shorter duration than PRK. Flap thickness may influence corneal transparency [2]. The keratocyte population located in the anterior stroma is at particular risk to suffer activation and transformation into myofibroblasts, producing a haze.

Ancillary Test

Confocal microscopy is the most adequate examination to evaluate this alteration. The amount of reflectivity in the anterior stroma appears as a peak after the epithelium. The confocal microscopy examination showed keratocyte activation in the stromal ablation zone (Fig. 56.2). The slit-lamp examination is useful in examining subclinical haze.

Surgical/Medical Intervention

The patient underwent an uneventful LASIK procedure; both eyes were targeted for distance. Flap creation at a depth of 100 μm was performed using the Intralase™ FS (IntraLase Corp) and corneal stromal ablation by the AMARIS SCHWIND excimer laser. Postoperative evaluation was almost normal. The slit-lamp examination showed a clear interface and well-positioned flap.

Outcome

After 1 month, the slit-lamp examination showed a very tender opacity. Uncorrected visual acuity (UVCA) was 20/20 in both eyes. The keratometric reading was 40.10/40.65 × 41° in RE and 39.39/39.84 × 142° in LE (Fig. 56.3).

What to Learn from This Case

LASIK is an effective and safe treatment for moderate myopia [3]. Keratocyte activation after LASIK may be a natural defense mechanism in response to corneal trauma, attempting to reconstruct and preserve the original conformation of the corneal tissue. Even if a thin flap permits LASIK treatment in a thin cornea, keratocyte

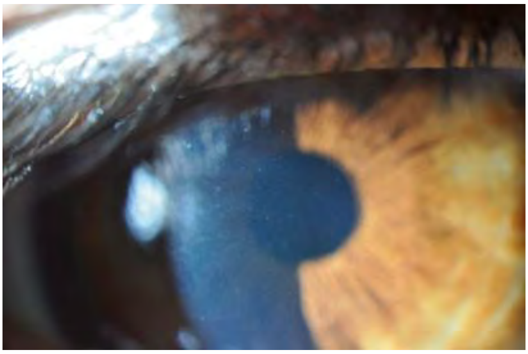

Fig. 56.3 Slit-lamp examination 1 month postoperative shows tender oval opacity

activation can frequently occur on the other side. Prophylactic effect of MMC 0.2 % may also be used for patients with a thin flap; however, it is often unnecessary because keratocyte activation does not normally affect the visual performance of the eyes [4].

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PRK and Epidemic Keratoconjunctivitis

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Why Is This Case Relevant for the Refractive Surgeon?

As photorefractive keratectomy became a popular refractive surgery procedure, Talamo theorized that the destruction of Bowman's layer during uneventful photorefractive keratectomy (PRK) causes abnormal healing, subepithelial infiltrates, and associated scarring [1]. Recurrent adenoviral stromal keratitis is thought to express a delayed hypersensitivity immune response to viral antigens in the corneal stroma [2].

Refractive surgeons should be aware that damages in Bowman's layer and hyperactiveness of keratocytes induced by PRK may cause an abnormal healing response in a patient who suffers from epidemic keratoconjunctivitis (EKC) [3].

Case Background

A 33-year-old woman underwent bilateral uneventful PRK for moderate myopia of −5.50 −0.50 20° in the right eye and −5.75 −0.50 20° in the left eye. The best corrected visual acuity (BCVA) was 20/20 in both eyes. Preoperative corneal pachymetry was 515 μm in both eyes. Keratometry readings before surgery were 44.21 /45.12 × 24 ° in the right eye and 44.35 /45.13 × 10° in the left eye. According to the topography, her corneal surface was regular. The slit lamp and fundus examinations were normal. She had worn soft contact lenses for many

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years. Before surgery, our patient had not had a clinical history of adenoviral keratoconjunctivitis in either eye. Uneventful transepithelial photorefractive keratectomy was performed in both eyes. MMC 2 % was applied for 30 sec. The total calculated ablation depth was 170 μm in the right eye and 157 μm in the left eye (residual stoma in the right eye 345 and 358 μm in the left). Postoperative treatment was ciprofloxacin (Oftacilox®, Alcon, Spain) one drop three times a day for 7 days, dexamethasone (Maxidex®, Alcon, Spain) one drop five times a day for 7 days followed by fluorometholone (FML®, Allergan Inc., USA) one drop four times a day tapering to one drop every 3 weeks, soft bandage contact lenses while healing, and analgesic pills orally if necessary. Postoperative evaluation at 1 week was normal, the slit lamp examination showed a complete reepithelialization in both eyes. After 1 month the uncorrected visual acuity (UCVA) was 20/20. According to the topography, her corneal surface was regular and pachymetry was 430 μm in both eyes. The slit lamp examination showed no anomalies and intraocular pressure (IOP) was 18 mmHg in both eyes. Corneal haze and scarring were absent. After 4 years she presented at the emergency ophthalmology department with acute left eye redness, blurry vision, foreign body sensation, and photophobia. The patient reported left eye injury (a scratch from her child). UCVA was 20/50 in the left eye. The slit lamp examination revealed corneal erosion. The treatment was ciprofloxacin (Oftacilox®) ointment three times a day, cycloplegic drops three times a day, and dexpanthenol (Recugel®, Allergan Inc., USA) overnight. The next control appointment showed a clear and smooth cornea without a fluorescein staining and infiltration, with the patient reporting improved vision (Fig. 65.1). Ten days after the injury, the patient complained of severe pain of the left eye and a watery mucoid discharge. The slit lamp examination revealed in the left eye eyelid edema, reddening and swelling of the plica semilunaris and lacrimal caruncle, conjunctival injection, chemosis, follicular conjunctivitis and ecchymosis, cornea without fluorescein staining, and no anterior chamber reaction. The right eye was normal. IOP was 14 mmHg in both eyes. There was preauricular and submandibular adenopathy. The treatment was ciprofloxacin (Oftacilox®), artificial tears, and a cool compress. Four days later the slit lamp examination of the left eye showed eyelid edema, swelling and conjunctival injection, the cornea without fluorescein staining with multifocal subepithelial infiltrates, and no membranes and pseudomembranes on the tarsal conjunctiva. Fluorometholone (FML®) 1 drop three times per day was added. A few days later the patient complained of photophobia and permanent glare. Her UCVA was 20/80 in the right eye and 20/70 in the left eye. The slit lamp examination in both eyes revealed corneas stained with a fluorescein solution, and coin-like infiltrates (keratitis nummularis or Dimmer's keratitis) covered the entire corneal surface (Fig. 65.2 and 65.3). IOL was 18 mmHg in the right eye and 16 mmHg in the left eye. We diagnosed the epidemic keratoconjunctivitis; the diagnosis was based on the history, signs, and symptoms.

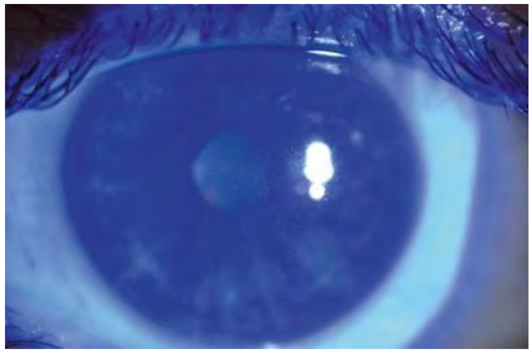

Fig. 65.1 The smooth cornea without a fluorescein staining

Main Problem to Solve

How do we manage an abnormal corneal reaction following PRK? Should we expect an abnormal corneal reaction after PRK (exaggerated corneal infiltration) in the context of KCE? What is an appropriate treatment for subepithelial infiltrates associated with KCE after PRK?

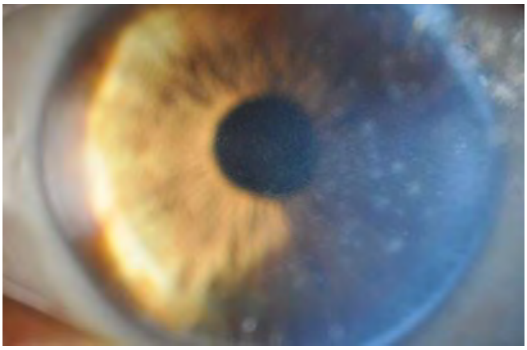

Fig. 65.2 Subepithelial infiltrates after EKC

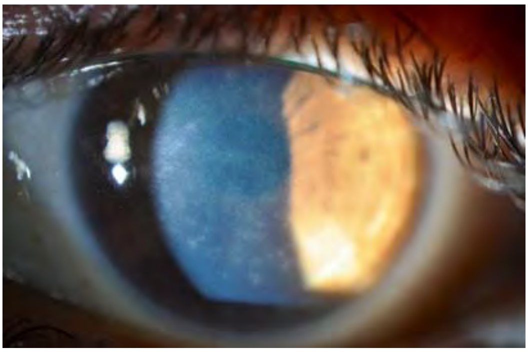

Fig. 65.3 Subepithelial infiltrates after EKC

Ancillary Tests

BCVA, UCVA, pachymetry, topography, slit lamp examination, and intraocular pressure measurement. We did not perform a cell culture in combination with immunofluorescence staining (CC-IFA) and antigen detection or polymerase chain reaction (PCR) because the diagnosis was based on the history and characteristic/pathognomonic signs.

Surgical/Medical Intervention

Fluorometholone (FML Forte®) four times a day was prescribed tapering to one drop a week. Although the destruction of the Bowman's layer during PRK may cause a problem with subepithelial infiltrates [1], some authors describe the same treatment (topical MMC in conjunction with PRK) for subepithelial infiltrates because of EKC's production of positive visual and refractive results [4]. Other authors describe a positive outcome after using cyclosporine A (CSA) 1 % to reduce subepithelial infiltrates resistant to corticosteroid eyedrops [5].

Outcome

After 4 months of treatment, UCVA was 20/20 in both eyes. Slit lamp examination revealed no secretion, no conjunctiva injection, coin-like infiltrates, and a cornea without a fluorescein staining.

What to Learn from This Case

PRK with mitomycin C is a promising treatment for moderate myopia, but a surgeon should be meticulous in selecting patients. It is important to keep the patient's clinical history in mind, especially those involving viral keratoconjunctivitis. EKC is a serious complication after excimer laser photorefractive procedure. As reported in the literature, EKC reoccurrence after PRK is more frequent in the eye without refractive surgery [3]. The cornea's response to EKC can be abnormal after PRK due to the keratocytes' hyperactivation and a loss of Bowman's layer after the refractive procedure [3, 6]. It is widely known that corneal infiltrates are an immune response to suspected adenoviral antigens deposited in corneal stroma during the primary adenoviral infection, and this is a cause of frequent relapses [3, 7]. The prompt diagnosis and the use of topical steroids seem to be effective in managing EKC after refractive surgery [3]. CSA 1 % eyedrops may be an effective corticosteroid-sparing agent in subepithelial infiltrates resistant to corticosteroid therapy.

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Ectasia Post PRK at Delayed Onset

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Maria Jose Ayala, Alessandro Abbouda, and Jaime Javaloy

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Why Is This Case Relevant for the Refractive Surgeon?

Refractive surgeons are familiar with the risk of ectasia after LASIK. Ectasia after PRK may be due to retreatment, unrecognized keratoconus or forme fruste keratoconus [1, 2]. Koch [3] reported the case of a patient who developed bilateral corneal ectasia after an uneventful PRK. Risk factors for the development of ectasia following excimer laser include high myopia, reduced preoperative corneal thickness, a reduced residual stromal bed after laser ablation and asymmetrical corneal steepening (forme fruste keratoconus) [4]. However, none of these characteristics definitively predict the development of ectasia. We present a case in which corneal ectasia developed 14 years after PRK with no identifiable risk factors, even when a surface ablation was performed.

Case Background

A 21-year-old man was evaluated for refractive surgery to correct moderate myopia. No history of chronic eye rubbing, trauma, or atrophy was reported, and the patient had no family history of corneal ectasia. His best corrected visual acuity (BCVA) was 20/30 in both eyes with a manifest refraction of −7.5 −1 × 20° in the right eye and −6.5 −1.5 × 160° in the left. The preoperative central thickness was 610 μm in

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the right eye and 597 μm in the left. The keratometry reading was 43.24/44.39 × 110° in the right and 42.33/43.35 × 89° in the left and the corneal topography was normal in both eyes (Fig. 71.1a). In May 1995, the patient underwent PRK. The postoperative period was uneventful and the slit lamp examination showed no abnormalities. After 1 year, the patient's corrected distance visual acuity (CDVA) was 20/20 in both eyes with a manifest refraction of −0.75 −0.75 × 60° in the right eye and −0.75 −0.5 × 160° in the left eye. The keratometry reading was 38/38.3 × 94° in the right eye and 37.66/39.35 × 71° in the left eye. The aspect of the images was normal with no detectable asymmetry (Fig. 71.1b). The central corneal thickness was 530 μm in both eyes. We opted for a new PRK treatment. In August 1996, the patient's BCVA was 20/25 in the right eye and 20/20 in the left eye with a manifest refraction of −2.5 −1 × 70° in the right eye and −3.5 in the left eye. Keratometry reading was 37.7/37.96 × 89° in the right eye and 38/38.5 × 73° in the left eye, showing a symmetrical and well-centred myopic ablation (Fig. 71.1c). The slit lamp examination revealed a tender haze. The patient was not satisfied with his vision, and in December 1998, he underwent a PRK treatment. In June 1999, his BCVA was 20/32 in the right eye and 20/40 in the left eye with a manifest refraction of +2.5 in the right eye and +1.75 in the left. Keratometry reading was 36.6/36.76 × 68° in the right eye

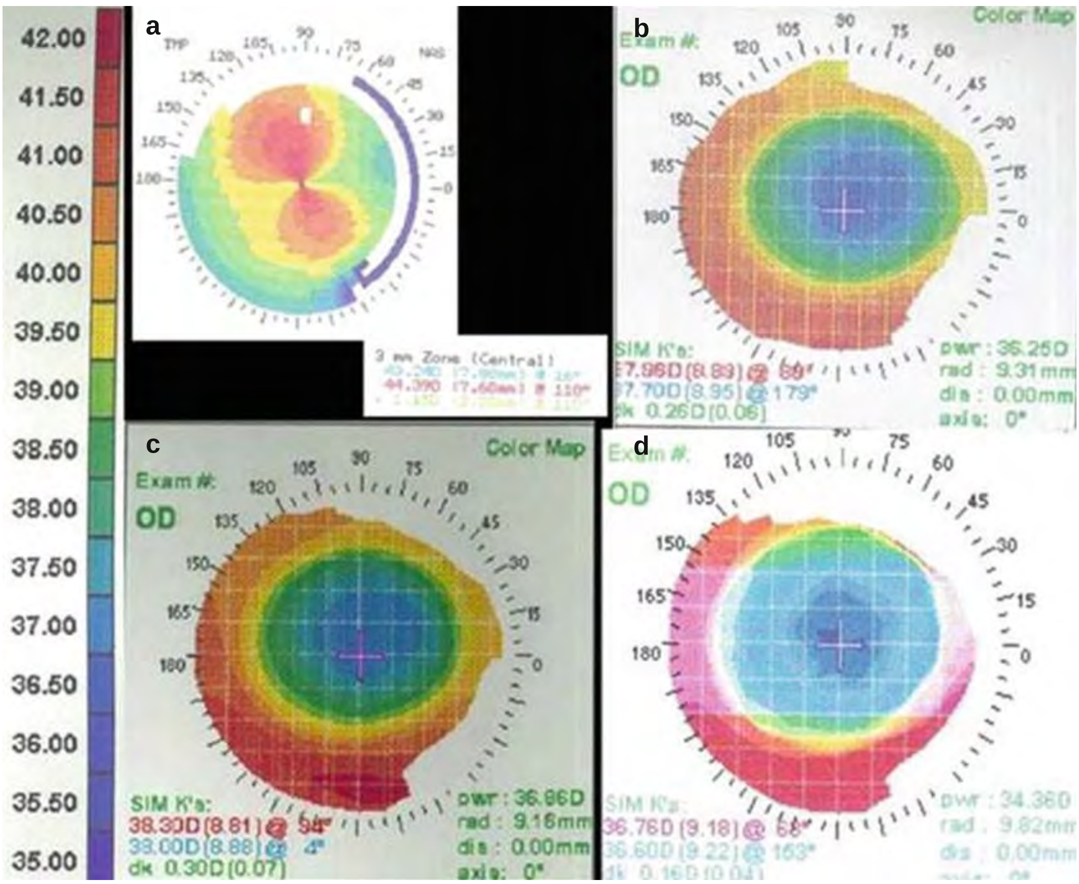

Fig. 71.1 (**a**–**d**) These pictures show a topography evolution axial scan (**a**) before the refractive treatment and (**b**) 1 year, (**c**) 2 years (**d**) and 4 years after the refractive treatment

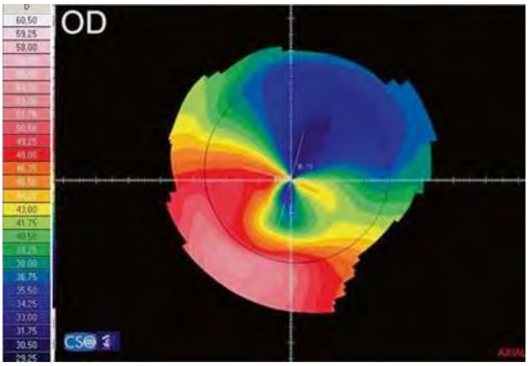

Fig. 71.2 Topography shows an inferonasal ectasia and irregular astigmatism 14 years after the primary procedure

and 35.75/35.3 × 171° in the left eye. The topography did not reveal signs of ectasia or irregular astigmatism (Fig. 71.1d). After 3 months, the refraction shifted again through a myopic value. The patient's BCVA was 20/32 in the right eye and 20/30 in the left eye with a manifest refraction of −3.5 −1 × 80° in the right eye and −4 −1 × 160° in the left. The slit lamp showed diffuse haze. The pachymetry was 480 μm in the right eye and 510 μm in the left eye. Keratometry reading was 37.9/38.3 × 104° in the right eye and 38.1/39.1 × 89° in the left eye. No surgical treatment was performed at this time. Ten years after, the patient began to complain of progressive vision reduction in the right eye. His BCVA was 20/200 in the right eye and 20/100 in the left eye with a manifest refraction of −3 –3 × 45° in the right eye and −2.5 −2 × 130° in the left. The topography showed an inferonasal ectasia with an irregular astigmatism (Fig. 71.2). The keratometry reading was 36.25/42.24 × 166°. The patient refused intracorneal ring segments and corneal collagen cross-linking (CXL). We opted for a rigid gas permeable contact lens while the patient considered the proposed surgery.

Main Problem to Solve

In this case, we did not find evident risk factors for the development of ectasia. The stromal bed residual after the last treatment was more than 400 μm. The patient did not rub his eyes. We excluded forme fruste keratoconus. The only risk factors to consider were the patient's age and retreatments with excimer laser.

Ancillary Tests

On the basis of pathophysiology of post-refractive surgery, ectasia can be explained by interlamellar biomechanical slippage (interlamellar fracture) followed by subsequent interfibrillar biomechanical slippage (interfibrillar fracture) as opposed to direct primary collagen fibril failure (fibrillar fracture) [5].

Surgical/Medical Intervention (with Video if Needed)

Traditional treatment for iatrogenic ectasia includes rigid gas permeable contact lens and an intracorneal rigid segment. Recently, several studies reported on riboflavin UVA-induced corneal collagen cross-linking (CXL) [6]. However, the most frequent choice for eyes suffering advanced ectasia is corneal transplantation (DALK). In our case, the patient refused the treatment proposed with intracorneal rings.

Outcome

One year after PRK, the patient's visual condition was worsening. His BCVA was 20/40 in the right eye and 20/25 in the left eye with a manifest refraction of −8.5 × 55° in the right eye and −0.75 –3.5 × 120° in the left. The topography showed an evident ectasia larger than the previous examination with a severe irregular astigmatism. The keratometry reading was 36.78/44.78 × 165°. The patient wanted to pursue the contact lens device, declining further surgery.

What to Learn from This Case

PRK has been proven as a safe, simple and effective procedure to correct low to moderate myopia. Alio et al. [7] reported few complications among 3,000 cases.

Refractive surgeons should be aware of the possibility of corneal ectasia occurrence in cases of low to moderate myopia, low ablation and enough residual stromal bed after ablation even when a corneal flap is not performed such as in a PRK.

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Angle-Supported Phakic IOL Migration Following Trauma

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Electronic supplementary material The online version of this chapter (10.1007/978-3-642-55238-0_83) contains supplementary material, which is available to authorized users.

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Why Is This Case Relevant for the Refractive Surgeon?

Rotation of the angle-supported PIOL is a potential long-term complication of phakic IOL [1]. Rotation can occur in all models of AS PIOLs, especially following trauma. The Kelman Duet anterior chamber intraocular lens, because of its three-point fixation, can rotate in a counterclockwise direction [2].

Case Background

A 40-year-old woman with a history of myopia and astigmatism in both eyes was implanted at age 32 with a Kelman Duet angle-supported phakic IOL. Refraction before surgery was −14-0.75 × 60° in the right eye (RE) and −14.5-2 × 115° in the left eye (LE). Preoperative data showed a keratometric value 43.2/43.8 × 84° in the RE and 43.5/44.2 × 11° in the LE. Her best corrected visual acuity (BCVA) was 20/20 in both eyes. The preoperative central thickness was 470 μm in both eyes. The endothelial cell count showed 2,283 cell/mm^2 in the RE and 2,045 cell/mm^2 in the LE. Measurement of the anterior chamber was performed with the OCT Visante. In the RE, the anterior chamber depth was 3.13 mm and the angle-to-angle distance was 11.43 mm. In the left eye, these measurements were 2.98 mm and 11.34 mm, respectively. A Kelman Duet was implanted.

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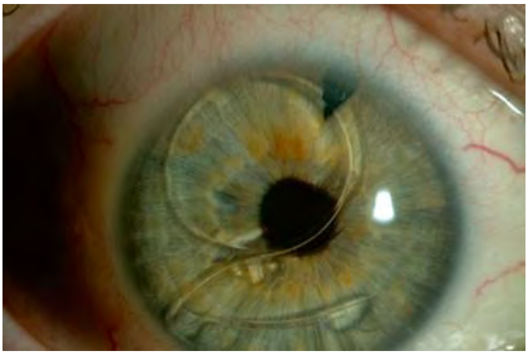

Fig. 83.1 Slit lamp examination 18 months after the first surgery revealed IOL displacement

The lens power was −14 diopters in both eyes with a relaxing incision in the LE. The diameter was 12 mm. The postoperative period was uneventful. After 18 months, the patient presented to our department complaining of foggy vision in the RE after an incidental blunt trauma. Her BCVA was 20/32 in the RE and 20/20 in the LE. The slit lamp examination revealed a lens rotation in a counterclockwise direction and the displacement of the haptic of the lens through the peripheral iridectomy, with the double support dislocated into the anterior chamber (Fig. 83.1). The lens was centered, removing the haptic from the ciliary sulcus and rounding the lens in 2 clockwise directions. The postoperative was uneventful with speedy and satisfactory recovery of visual acuity. After 3 years, the patient returned to our clinic with the same symptoms. She referred a new blunt trauma 3 days before in the RE. The slit lamp examination revealed the same dislocation.

Main Problem to Solve

Decentration of the lens optic due to poor selection of lens size occurs in a low percentage of cases. Decentration produces an imbalance in the forces of angle support [3]. Although the lens size was correct in this case, trauma managed to displace the lens.

Ancillary Tests

The endothelial count was performed excluding damage and endothelial cell loss related to frequent trauma. The cell count was 2,045 cell/mm^2 in the RE. We decided to recenter the lens and not explant it.

Surgical/Medical Intervention

Under topical anesthesia, a paracentesis was performed in the limbus at 10 h. After injecting 0.1 ml of acetylcholine, the anterior chamber was filled with cohesive ophthalmic viscosurgical devices (OVD). Using a Sinskey hook, the lens was rotated in a clockwise direction, removing the haptic from the ciliary sulcus (Video 83.1).

Outcome

Three days after surgery, the patient's manifest refraction was −0.5/70° and her BCVA was 20/20. The slit lamp examination revealed a centered lens and haptics (Fig. 83.2).

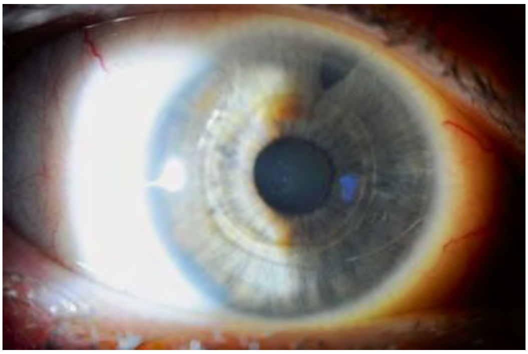

Fig. 83.2 Slit lamp examination after surgery revealed a centered IOL

What to Learn from This Case

In cases of blunt trauma in a patient implanted with an angle-supported phakic IOL, it seems that prompt management can prevent severe complications such as endothelial decompensation. Furthermore, obtaining a patient's detailed history is advised in order to avoid implanting devices in patients exposed to a frequent risk of blunt trauma.

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Misaligned STAAR Toric Implantable Collamer Lens (ICL)

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Jaime Javaloy and Alessandro Abbouda

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Why Is This Case Relevant for the Refractive Surgeon?

The toric implantable collamer lens (TICL; STAAR Surgical Co., Monrovia, Calif) is a posterior chamber, sulcus-supported, phakic IOL used to reduce or eliminate myopia, hyperopia, or astigmatism [1, 2]. The refractive surgeon should use proper axis orientation to achieve the desired optical results.

Case Background

A 26-year-old woman with bilateral myopic astigmatism presented for a refractive surgery evaluation. Her manifest refraction was −5.75 −4 × 10 in the right eye and −6.25 − 4 × 170 in the left eye. Her best corrected visual acuity (BCVA) was 20/20 in both eyes. Her preoperative central thickness was 552 μm in the right eye and 530 μm in the left eye. The keratometry reading was 42.28/44.384 × 93 in the right eye and 42.69/44.86 × 93 in the left eye. Papillary sizes were 6 mm under mesopic light condition. The corneal topography showed asymmetrical bowtie patterns. To avoid the risk of ectasia post-LASIK and to provide the best

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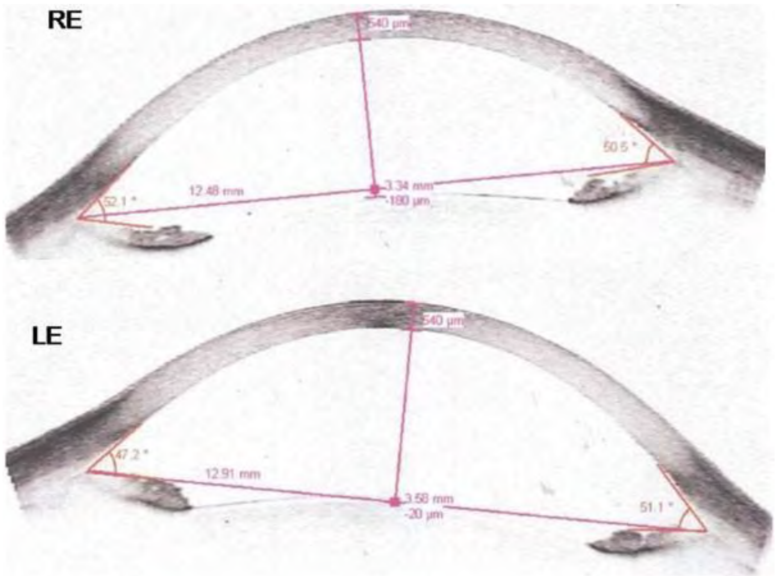

Fig. 84.1 OCT Visante and anterior chamber measurement in the right and left eye

quality vision, we decided to implant a posterior chamber phakic IOL. The endothelial cell count was 3,534 cell/mm^2 in the right eye and 3,344 cell/mm^2 in the left eye. Measurement of the anterior chamber was performed with the OCT Visante (Fig. 84.1). The anterior chamber depth was 3.34 mm and the width was 12.48 mm in the RE; anterior chamber depth was 3.51 mm and width was 12.91 mm in the LE. The TICL calculation software selected a lens power for the right eye of −11 + 4 × 93 with a diameter of 13.2 mm and for the left eye a power of −11.5 + 4.5 × 99 with a diameter of 13.2 mm. Calculating software guided the plan to implant the lens at 7° clockwise in the right eye and 19° clockwise in the left. Two days after implantation, the patient was not satisfied. She had a manifest refraction of +1.5 − 3.5 × 10 in the right eye and +0.75 − 2.50 × 20 in left. Her BCVA was 1 in both eyes. A slit lamp examination showed that the lenses were rotated based on the original plan. Both lenses were rotated at 30° clockwise and were replaced. However, at 2 weeks the patient again complained of foggy vision in the left eye. The slit lamp examination showed a new rotation at 30° clockwise. The lens was replaced and on the same day an autorefractometry was performed which showed emmetropia. The day after, the lens was again at 30°.

Main Problem to Solve

We had to determine why the lens implanted in the LE experienced recurrent rotation, even when the size of the IOL had been calculated according to the recommendations of STAAR.

Ancillary Tests

The most helpful tool to calculate the treatment was to repeat the measurement of the anterior chamber width through OCT Visante and IOL master Zeiss. Both instruments showed similar values.

Surgical/Medical Intervention

We decided to replace the lens with one of larger diameter. The TICL calculation software selected a lens power of −11.5+4×8 and a diameter of 13.7 mm with the plan of explantation at 2° clockwise.

Outcome

After 2 months of the last treatment, the uncorrected visual acuity in both eyes was 20/20 and the marks of the lens indicating the axis of the

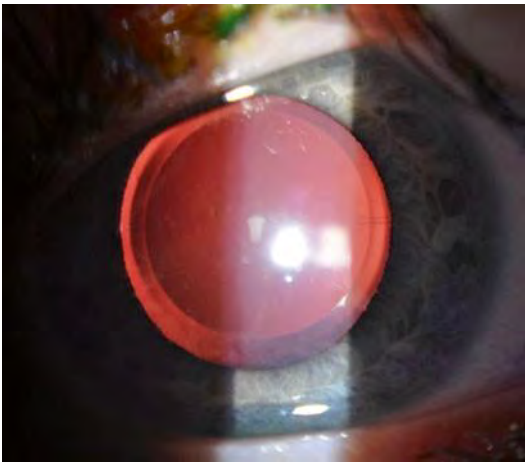

Fig. 84.2 Slit lamp examination showed lens alignment to the axis of astigmatism

astigmatism were aligned according to the desired orientation (Fig. 84.2).

What to Learn from This Case

A recent article [3] suggests that the sulcus diameter is the most important measure to obtain the best predictable postoperative vault height. One of the most difficult things about the phakic IOL implantation in the ciliary sulcus is estimating the correct distance between the sulci. New instruments such as the IOL master and OCT Visante can help size the PIOL implantation. In this case we had to use empirical algorithms to estimate the distance. Reinstein et al. [3] measured the sulcus diameter using Artemis 2 very high-frequency (VHF) digital ultrasound (ArcScan Inc.). Frequent misalignment of the lens is related to an inadequate sulcus diameter, with the only solution to change the lens.

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85 ICL and Sequential Bilateral Pupillary Block

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Contents

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Why Is This Case Relevant for the Refractive Surgeon?

The refractive surgeon should be aware of the risk of pupillary block after Implantable Collamer Lens (ICL) implantation. If surgery before a neodymium:YAG (Nd:YAG) laser iridotomy is performed, the surgeon must be aware of the complete permeability of these iridotomies. The Visian Implantable Collamer Lens (ICL; STAAR Surgical) is a sulcus-placed, phakic, posterior chamber intraocular lens (PIOL) used to manage myopia, hyperopia, and myopic compound astigmatism in phakic patients [1, 2]. The ICL is designed to vault anteriorly to avoid contact with the crystalline lens. The vault is at risk of causing pupillary block; thus ICL surgery requires prophylactic placement of laser peripheral iridotomies. If the peripheral iridotomies are imperforate, pupillary-block angle closure can develop. Block can be treated with additional laser peripheral iridotomies [3, 4]. The new model of ICL surgery includes a small central hole to ensure adequate aqueous humor circulation, even in the absence of a peripheral iridotomy.

Case Background

A 38-year-old woman with bilateral myopic astigmatism presented for a refractive surgery evaluation. Her manifest refraction was −8.75 − 1.25 × 95 in the right eye and −11 − 1 × 180 in the left eye. Her

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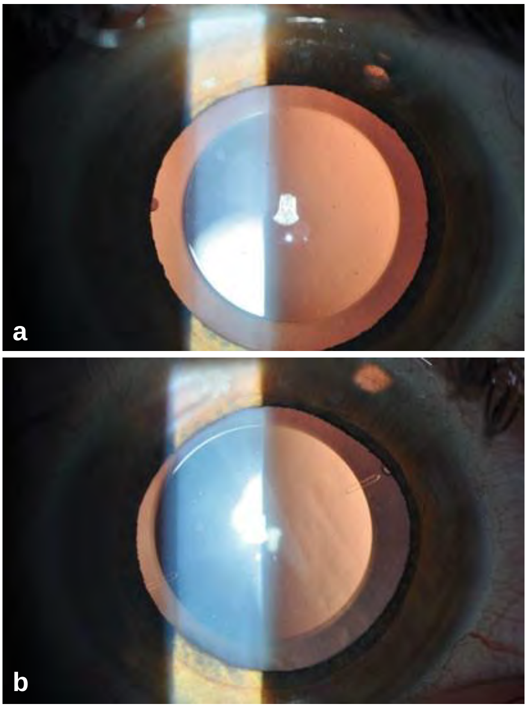

Fig. 85.1 The slit lamp examination at the end showed full iridotomy and normal vault in both eyes (**a**, **b**)

best corrected visual acuity (BCVA) was 20/20 in both eyes. Her preoperative central thickness was 491 μm in the right eye and 509 μm in the left eye. Her keratometry reading was 44.78/45.38 × 13 in the right eye and 45.36/45.36 × 180 in the left eye. Corneal topography showed asymmetric astigmatism with a KPI (keratoconus probability index elevated) pattern in both eyes. To avoid the risk of ectasia post-LASIK, we decided to implant a posterior chamber phakic IOL. The endothelial cell count was 2,646 cell/mm^2 in the right eye and 2,208 cell/mm^2 in the left eye. Measurement of the anterior chamber was performed with the OCT-Visante (Fig. 85.1). The anterior chamber depth was 3.3 mm and the width was 11.6 mm in the right eye; the anterior chamber depth was 3.3 mm and the width was 11.8 mm in the left eye. The TICL calculation software selected a lens power for the right eye of −8.5 − 1.25 × 90 with a diameter of 12.6 mm and for the left eye a power of −10.5 − 1 × 180 with a diameter of 12.6 mm. The model implanted was ICM, STAAR Surgical lens. The implant was uneventful under local anesthesia and a peripheral iridotomy was performed in both eyes at 7 h.

On the first day after surgery, the patient complained of headache, nausea, and low vision in the left eye. The intraocular pressure (IOP) in the LE was 32 mmHg. A slit lamp examination revealed shallow anterior chamber and a partial thickness iridotomy which did not include the pigmentary epithelium. This peak of IOP was successfully treated, as described later. The right eye had a wide pharmacologic mydriasis and IOP of 8 mmHg the first day, but the next day the IOP was 30 mmHg. Slit lamp examination of the RE the second day was comparable to that of the LE the previous day.

Main Problem to Solve

Angle closure in the context of a shallow anterior chamber following the ICL placement has at least three possible etiologies: (1) Malignant glaucoma: the crystalline lens is displaced anteriorly and the space between the ICL and the anterior capsule is diminished or absent. The anterior chamber is shallow. (2) Pupillary block: Result of imperforate peripheral iridotomies. The chamber is shallow and lens vaulting is exaggerated. (3) Angle closure occurs secondary to direct angle compression from oversized and excessively vaulted ICLs.

Ancillary Tests

Slit lamp examination, OCT, and a record of the IOP are used to manage this situation. Pupil dilation and observation over 12–24 h can differentiate these three conditions [4]. If dilation results in immediate deepening of the anterior chamber and a reduction in the IOP, phakic PC IOL pupillary block is present. On the contrary, an oversized phakic PC IOL does not permit anterior chamber deepening after mydriasis. Posterior chamber viscoelastic block resolves over 12–24 h as the viscoelastic material vacates the posterior chamber. Anterior segment OCT helps in diagnosis. Malignant glaucoma is evident if there is no space between the crystalline lens and ICL. Pupillary block is present if there is a large space between the crystalline lens and ICL. High ICL vaulting occurs with marked anterior displacement of the iris.

What to Learn from This Case

Pupillary block and cataract formation are potential complications of all phakic IOLs. Pupillary block after phakic PC IOL implantation can occur despite the presence of incomplete peripheral iridotomies if they do not include the full

Surgical/Medical Intervention

Slit lamp examination revealed that the periph- eral iridotomy was not appropriately thick; each iridotomywascompletedwithaneodymium:YAG(Nd:YAG) laser under high power. YAG laser treatment was applied over the pigmentary epi- thelium. A single burst of 3.0 mJ was enough to perforate the pigmentary epithelium. A flow of aqueous from the posterior to anterior chamber occurred instantly upon penetration of the iris pigment epithelium, with immediate deepening of the peripheral anterior chamber and normal- ization of the ICL vault. Oral acetazolamide and brimonidine tartrate/timolol maleate drops 2 times a day were prescribed.

Outcome

Three months after surgery, the patient's visual acuity was 20/20 in both eyes. The slit lamp examination revealed a normal anterior segment (Fig. 85.1).

thickness of the iris [4]. In our case, the persis- tence of a wide mydriasis in the first visit pre- vented elevation of the IOP in the first 24 h. The key clinical feature of phakic PC IOL pupillary block, which distinguishes it from malignant glaucoma, is the absence of a forward displace- ment of the crystalline lens.

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