Difficult and Complicated Cases in Refractive Surgery

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To my Father,
All your help and support has allowed me to become a doctor. Thank you from the bottom of my heart.

Alessandro

Foreword

Refractive corneal surgery, including Lasik, PRK/Lasek, corneal inlays, collagen cross-linking, intracorneal ring segments, thermal keratoplasty, incisional refractive surgery including radial and astigmatic keratotomy/limbal relaxing incisions, and phakic intraocular lenses, together represent the second most common surgical procedure performed by the ophthalmic surgeon worldwide. While cataract surgery dominates at approximately 20,000,000 procedures per year globally, refractive corneal surgery including those procedures used in combination with cataract surgery together accounts for over 5,000,000 surgical interventions annually. In the modern era of ophthalmology, every ophthalmic surgeon must consider the refractive outcomes generated by every procedure, as a patient's daily visual function and quality of life are significantly impacted by their residual refractive error following surgery. Like every invasive procedure, refractive corneal surgery and phakic intraocular lenses are associated with complications. The proper prevention and timely management of intraoperative and postoperative complications is the hallmark of the master ophthalmic surgeon.

In their new book, *Complicated Cases in Refractive Surgery*, two master surgeons, Jorge Alio, M.D., and Dimitri Azar, M.D., along with a carefully selected group of highly experienced and respected colleagues present us with an extraordinary compilation of 101 select cases of both common and rarer complications, including their presentation, management, and clinical outcomes. This style of teaching using real-life cases is extremely effective and popular with surgeons, as it provides a learning experience that is impactful and more easily

remembered than the typical didactic chapter referencing the published literature.

This new book, a follow-on publication to the same two editors' popular *Management of Complications in Refractive Surgery*, published in 2009 and translated into multiple languages, is a must read for every ophthalmic surgeon who performs refractive surgery along with those who help manage or encounter these patients in daily practice. The case presentation format is engaging and an easy read. The cases presented are well selected, are edited for maximum educational value, and provide the reader with one clinically useful pearl after another. Drs. Alio and Azar, thank you again for providing us with such a powerful and pleasant learning experience that is certain to benefit surgeons and patients worldwide for years to come.

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Preface

This is a unique book in which a clinical cases affected by complications of refractive surgery are presented as a series of cases to illustrate how, in practical terms, such complications can be managed.

In 2007, we published our book *Complicated Cases in Refractive Surgery*, which was well received and which has been translated into many different languages including Chinese. In that book, we offered state of the art pathogenesis and knowledge of management of complications in refractive surgery from classical techniques to the most recent innovations. In this book, we illustrate the practical knowledge and details that are necessary to achieve successful outcomes in many of these complex cases.

This book has been created based on the didactic technique known as "problem resolution." Problem resolution is a modern, innovative pedagogical method of teaching medicine. We should not forget, however, that 2400 years ago, on the island of Kos, Hippocrates and the Hippocratic doctors were applying the hands on method to teach their students. The practice of medicine was basically empirical, and it was not until later that the volume of medical science enabled formal theoretical teachingto be incorporated into the curriculum.

In this book, the reader will find a series of interesting cases that illustrate the most frequent and complicated cases in refractive surgery and how different authors have accomplished their solutions successfully. While mostly-cases with successful outcomes have been included we have tried to illustrate in 101 cases how potential nightmares can have happy endings. We have simplified the process of analyzing the cases and extracting what is really the practical message that each case offers.

Our hope is that the reader will learn how difficult cases can be approached and solved, using the latest technology and medical knowledge available. Reproduction is a way to demonstrate, and demonstration is the basis of medical science. The art of being a doctor is using the scientific background that the doctor has jointly with his/her practice and experience that guides the medical judgment toward the best option for the patient. We hope that you will find the chosen cases of interest and be intrigued by the medical challenge they represent. Finally, the successful outcome that has been accomplished by the talented and innovative coauthors of this book.

We want to thank our talented coauthors for providing cases with innovative techniques and successful outcomes. We also would like to thank our

associate editors for the many hours of work devoted to gathering together these cases, to simplify the process of editing, and to offer a unique format which can be easily comprehended and readily applied to your own patients. In editing this book, we have felt that we have been walking on the island of Kos and writing this book jointly with our Hippocratic colleagues.

Signed in Alicante and Chicago 2015

Alicante, Spain — Jorge L. Alió, MD, PhD
Chicago, IL, USA — Dimitri T. Azar, MD, MBA

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How This Medical Book Was Inspired

Aesculapius: The Symbol of Medicine and Hippocratic Medicine
Our Aesculapius in Alicante
By Jorge L. Alió and Alessandro Abbouda

Vissum Corporation Instituto Oftalmologico of Alicante exhibits an original roman statue dating from the first century A.D. The statue was found near a temple in the south of Messina. Our Aesculapius travelled around the word from the Chicago collection to Seville, and in September 2011 this statue arrived in Alicante thanks to the patronage of Prof. Alio who donated the piece to the center as a sign of respect for all patients and the medical profession.

The ground floor of the clinic was built based on the distribution of the Epidaurus temple where the statue could be observed from above and meanwhile the sick could sleep overnight on the bare ground beside the statue.

The statue possesses all the typical elements of Aesculapius. A mature man with a calm expression, a tunic around his waist, then draped over one of his shoulders and wrapped around his lower torso and legs; curly beard; thick hair; one arm resting on the snake staff and the other on his hip. The right arm and the snake staff have both been restored.

According to the ancient Greek legends, Aesculapius was the son of Apollo and Coronis. Coronis was unfaithful to Apollo, and Artemis, Apollo's twin sister, killed her for her unfaithfulness. Apollo felt sorrow for his unborn son and snatched the child Asclepius from his mother's corpse, saving him from death. Apollo then handed Aesculapius over to the centaur Chiron who became his tutor and mentor.

Chiron taught Aesculapius the art of healing. According to Pindar (Pythian Odes), Aesculapius also acquired the knowledge of surgery, the use of drugs, love potions and incantations, and according to Apollodorus (the Library), Athena gave Aesculapius a magic potion made from the blood of the Gorgon. With these gifts Aesculapius transcended the bounds of human knowledge.

The main attribute of Aesculapius is a physician's staff with a snake wrapped around it; this is how he was distinguished in the art of healing, and his attribute still survives to this day as the symbol of the modern medical profession. The World Health Organization has used Aesculapius' symbols as its emblem since its foundation in 1947.

There were many centers and schools of medicine, from Trikkis in Thessaly to the island of Cos. It is believed that Hippocrates, a great doctor of antiquity, practiced his trade on the island of Cos. It is also said that Hippocrates was a descendant of Aesculapius. His disciples received the teaching of medicine, listening to the explanation walking with him while he was attending patients.

The format of our book is inspired by Hippocrates' style of teaching medicine based on the resolution of problems.

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Part I

Complications in Refractive Laser Treatment Plan

Dear reader,

This chapter includes cases related to the importance of preoperative planning before performing refractive surgery. Refractive surprise is not common today with excimer laser technology, but in cases such as elevated myopia and hyperopia and more in cases of astigmatism, an error in power or axis may be devastating for the patient and the surgeon. Furthermore, it is increasingly common to receive patients for cataract surgery who have previously undergone a corneal refractive procedure. The expectations of these patients are very high in terms of refractive outcomes and until the present we lacked an exact formula to determine the best IOL power.

The cases in this chapter describe situations such as management of refractive shifts, IOL calculations following refractive surgery, cataract surgery prior to refractive surgery, management of high astigmatism, and avoiding corneal grafts. After reading this chapter, we hope that the planning and management techniques from these cases will allow you to plan and select safe refractive treatments for your patient and to manage unexpected problems.

For a theoretical complement, we suggest the first book of this series: J. L. Alio', D. Azar *Management of Complications in Refractive Surgery*, Chapter 6: Refractive Miscalculation with Refractive Surprise (pp. 103–112) and Chapter 7: Optical Aberration (pp. 113–152).

Furthermore, in the appendix of this book, you will find a "step-by-step approach for planning refractive correction of highly aberrated eyes in excimer laser refractive corneal surgery." This will help to explain the application of customized treatment described in some of the cases in this chapter.

Specific topics covered by the cases include hyperopic shift following RK resolved by corneal wavefront PRK (Case 1) and how to manage high refractive defect choosing two procedures, IOL and LASIK/PRK (Cases 2 and 3). Other cases cover the challenge of IOL calculation and the optical quality of hyperopic or myopic patients previously treated by refractive surgery (Cases 4 and 5); intraoperative aberrometry, a new tool used for post-refractive surgery IOL power calculations (Case 6); high amount of refractive astigmatism solved by using a toric IOL and subsequent LASIK (Case 7); and the corneal epithelium's ability to alter in thickness profile and compensate for changes

in stromal surface curvature (Case 8). Other cases cover sequential custom therapeutic keratectomy, a new tool for high irregular astigmatism (Case 9); how to manage high astigmatism after a penetrating keratoplasty (Case 10); how to solve corneal leukoma without a corneal transplant (Case 11); how to manage high astigmatism after a penetrating phaco wound burn (Case 12); and automated superficial lamellar keratectomy augmented with hyaluronic-assisted PTK as a new tool to avoid corneal graft (Case 13). We end with cases focused on the multifocal lens property and visual acuity (Case 14), an alternative treatment to amblyopia in consideration of difficult cases (Case 15), higher order of aberrations, the principal cause of poor scotopic vision after laser vision correction (Case 16), managing an unsatisfied patient after cataract surgery, a didactic case of monovision (Case 17), and errors in the excimer refractive program (Case 18).

Lesson to learn in these cases:

Case 1: Hyperopic result after corneal wavefront-guided PRK on an RK eye

A postradial keratotomy patient developed hyperopic shift and was treated by corneal wavefront PRK improving the refraction and the values of high order of aberrometry.

Case 2: Refractive laser treatment post phakic IOLs by LASIK

The complete correction of high refractive defect can find advantage from the joint effect of two different refractive procedures.

Case 3: Refractive laser treatment post ICL in high myopia by PRK

When a complete emmetropia is not achieved by ICL implantation and cornea is thick enough, a secondary PRK treatment could be a good solution.

Case 4: IOL calculation in a previous refractive hyperopic patient

How to solve the challenge of IOL power calculation and IOL selection in a hyperopic patient previously treated by corneal refractive surgery?

Case 5: Refractive surprise after cataract surgery solved in a patient that underwent corneal refractive surgery 12 years ago

The challenge of IOL calculation and the optical quality in a myopic patient previously treated by corneal refractive surgery. How to obtain a good result?

Case 6: Post-refractive surgery IOL power calculation, intraoperative aberrometry

The use of intraoperative wavefront aberrometry appears to increase the accuracy in post-refractive surgery IOL power calculation.

Case 7: Refractive lens exchange for high hyperopic astigmatism followed by LASIK

Different solutions to manage the high amount of refractive astigmatism remaining after the IOL implantation: to rotate the toric IOL, to explant the toric IOL, or to replace it with one with a different toricity?

Case 8: Transepithelial phototherapeutic keratectomy for irregularly irregular astigmatism

A transepithelial phototherapeutic keratectomy (PTK) procedure is a more appropriate and effective treatment than topography- or wavefront-guided

Hyperopic Result After Corneal Wavefront-Guided PRK on an RK Eye

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Jaime Aramberri Agesta

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Why Is This Case Relevant for the Refractive Surgeon?

Refractive surgery on a cornea with a previous radial keratotomy can be challenging in terms of laser programming, as corneal response to PRK can differ significantly from a normal cornea.

Case Background

A 50-year-old man complains of low vision on his RE after radial keratotomy (RK) surgery which was performed 12 years before. RE BCVA was 20/63 with +2.25 sph −3.25 cyl×135°, and LE BCVA, also operated by RK, was 20/32 with +0.50 sph −1.00 cyl×80°. Slit lamp exploration revealed 12-cut radial keratotomy on both eyes. There was a slight nasal decentration on the RE with respect to the pupil center. Corneal topography displayed a small optical zone and asymmetric bow-tie pattern with flatter inferior hemicornea. Total aberrometry confirmed high optical irregularity with a higher-order aberration RMS of 4.43 μ for a 6 mm area of analysis. Most affected coefficients were fourth-order spherical aberration and third-order coma. Fundus exploration showed a mild myopic macular atrophy and tilted optic disc in both eyes.

J.L. Alió et al. (eds.), *Difficult and Complicated Cases in Refractive Surgery*,
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Main Problem to Solve

The objective of the treatment is to improve corneal optics, increasing and centering the optical zone and decreasing high-order aberrations.

Ancillary Tests

Ectasia risk can be determined by corneal tomography and Ocular Response Analyzer (ORA) studies. Corneal aberrometry is the key point to calculate the shotfile to eliminate the higher-order aberrations. Spherical aberration correction will induce some sphere change that needs compensation when the case is programmed. It is important that the user knows the sign of this refractive change as depending on how the software is programmed it can be myopic or hyperopic. In this case, Schwind ORK-W software was used and the induced myopia was compensated using a surgeon-developed nomogram.

Surgical/Medical Intervention

Epithelium removal prior to PRK was performed mechanically after 20 s of 20 % ethanol solution. First, the high-order correction pattern, as calculated by the Schwind ORK-W software from corneal topography aberrometry with the Schwind ESIRIS laser, was ablated, and second, the refractive pattern with the correspondent sphere and cylinder compensation for the depth of the ablated Z(4,0), Z(3,−1), and Z(3,1) coefficients. The ORK-W software version was used to undercorrect HOA treatments, so 20 % overcorrection of all coefficients was programmed. The target refraction was −0.50 sph. 0.02 % mitomycin C was applied for 30 s on the ablated surface at the end of surgery.

Outcome

Three months after surgery, BCVA was 20/50 with +1.00 sph −0.50 cyl×180°. This meant a 1 D sphere equivalent refractive prediction error in the hyperopic side. Six months after surgery, a new PRK was performed and final refraction, 3 months later, was planned. Higher-order aberrations improved significantly, with a relevant decrease of most affected Zernike coefficients.

What to Learn from This Case

PRK sphere equivalent results are more variable than normal eyes, especially when higher-order corrections are added. Predictability can be even worse if subepithelial irregularity correction via transepithelial approach is aimed [1–5]. In our experience the variability is random and can be in both the myopic and hyperopic side. Therefore, programming has to be carefully designed and patients are informed about a higher rate of retreatment need. This case also illustrates the need for mitomycin application after PRK in patients with prior RK (Figs. 1.1, 1.2, 1.3, 1.4, and 1.5).

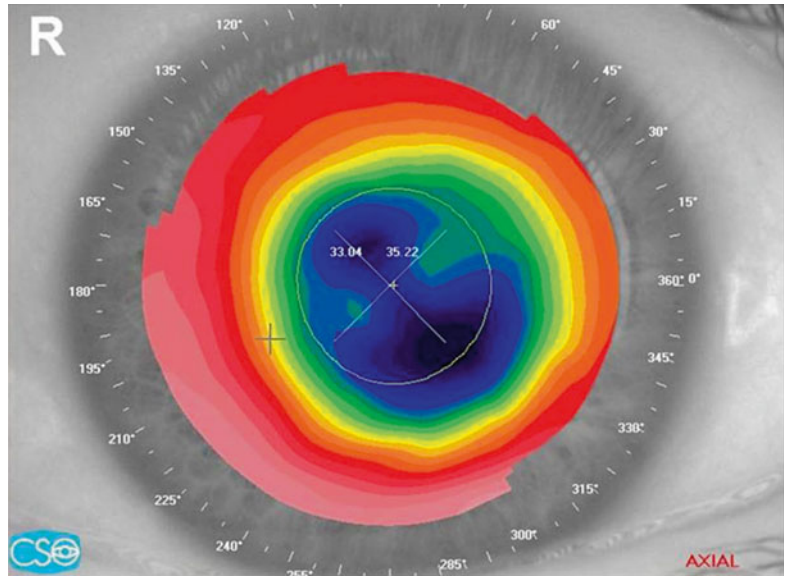

Fig. 1.1 RE corneal topography at first clinical visit: small optical zone with a slight nasal decentration. Irregular astigmatism with a flatter inferior component of the bow tie. Sim K astigmatism magnitude was −2.18 × 135°

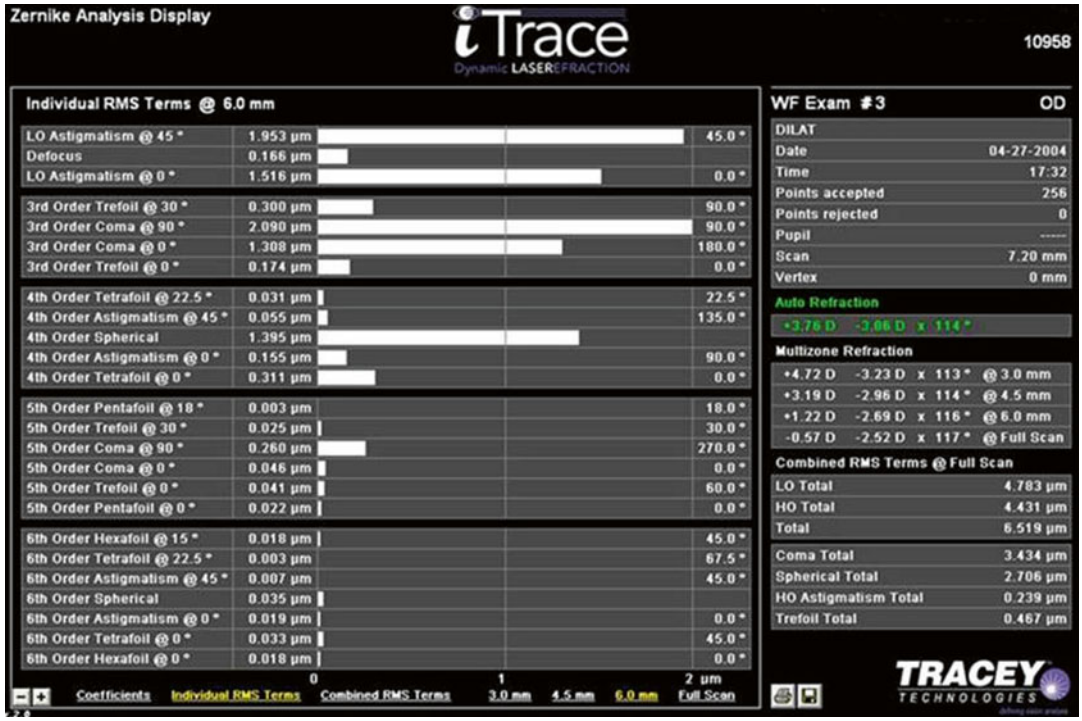

Fig. 1.2 Total aberrometry: high low-order astigmatism, third-order coma, and fourth-order spherical aberration. High-order aberration RMS is 4.43 µ (for a 6.00 mm area of analysis)

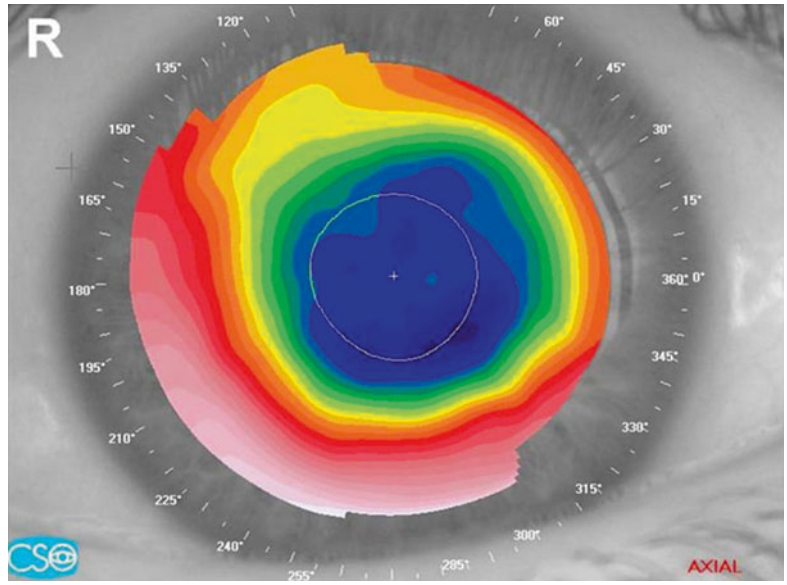

Fig. 1.3 Postoperative corneal topography: clear improvement of astigmatism and higher-order aberrations. Optical zone is wider, better centered, and more regular

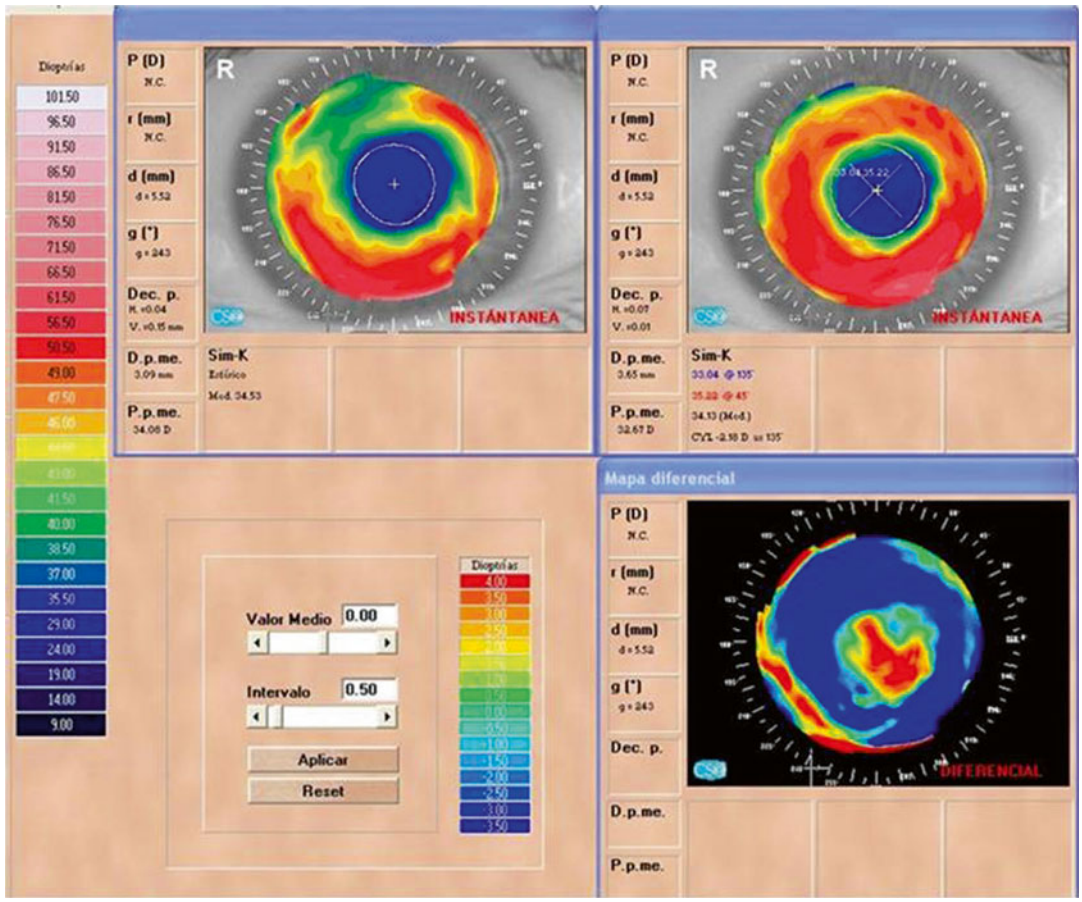

Fig. 1.4 The differential map helps in understanding the achieved correction in corneal curvature