

# chapter 5

## The Future of Refractive Surgery

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Over the past three decades, the ISRS/AAO and its members worldwide have tirelessly promoted a scientific approach to refractive surgery that has driven advances in technology and the understanding of surgical procedures, devices and instruments.

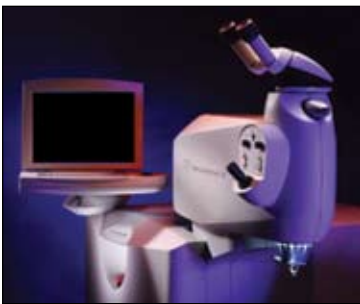
For example, the application of laser physics has revolutionized refractive surgical procedures through the introduction of instruments such as the excimer and femtosecond lasers. Similarly, advances in optics have led to improvements in our understanding of the contributions of corneal and lens optics to vision quality and have provided new approaches to maximizing visual function.

Ongoing studies that utilize new imaging technologies have improved our understanding of the accommodative mechanisms of the human eye and led to new approaches to treat presbyopia.

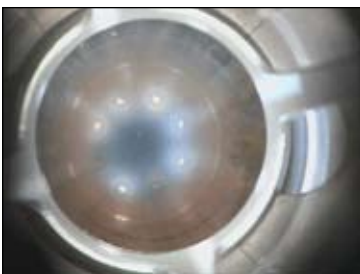
Just as important, molecular and cellular biological investigations in animal models have provided fundamental knowledge regarding cell and tissue effects of refractive surgical procedures. For example, we have come to understand the importance of the myofibroblast in haze development after surface ablation procedures, the contribution of the epithelial basement membrane in haze formation and the mechanism of action of once-empirical mitomycin C treatments.

Clearly, this revolution in the marriage of science and refractive surgery will not end. Continued advances in physics, optics, biology and other fields are inevitable and will assuredly lead to improvements in diagnosis and treatment of refractive abnormalities and complications.

Previously, our goal was merely to provide patients with adequate visual outcomes that allowed for the elimination of glasses. Today, refractive surgeons strive to improve the quality of life for patients through surgical manipulation of the refractive elements of the eyes. The subspecialty encompasses lens surgery and technological improvements including modern excimer laser customized



Intralase femtosecond laser



Intralase suction ring applied



ablation, corneal modeling techniques (rings, segments, etc.) and the correction of previously untreatable disorders like presbyopia. As the frontiers of refractive surgery expand, so must the surgeon's perspective.

Along the way, the cross-fertilization between technology and clinical experience has greatly improved our understanding of the anatomy and biomechanics of the eye, optics, cornea and aging lens. We have gained valuable new tools for examining the eye that continue to increase our knowledge.

The ISRS/AAO's continued commitment to innovation, education and the ethical dissemination of new ideas has been an important underpinning to the growth and success of refractive surgery. Millions of people have already benefited from the advances in our field, and millions more stand to gain from the discoveries we have yet to make and the techniques and technologies that will be refined in the years to come.

Following the example set by the ISRS/AAO in the last 30 years, our approach must continue to be one that balances the promotion of new ideas with the requirement for scientific rigor and effective clinical education.

The following scientific innovations illustrate the outstanding contributions made by the ISRS/AAO that promote continued scientific development and expand the horizons of refractive surgery.

### Wavefront-Guided Corneal Remodeling

Without question, excimer laser ablation is the leading modality in refractive surgery and will continue to be for some time to come. Today, surgeons can achieve better outcomes and high patient satisfaction with wavefront-guided ablations.

However, the full promise of wavefront is yet unrealized. As lasers and aberrometers continue to improve, wavefront treatments will become even more accurate at improving the optics of the eye by correcting specific, preexisting higher-order aberrations, something we cannot claim to do presently. Adaptive optics on wavefront systems may also allow us to demonstrate to patients in real time the effect of the optical correction on their vision.

Refractive surgeons continue to search for the best corneal ablation location. Most procedures are performed under a lamellar flap, but there are many innovative techniques such as Epi-LASIK, thin flaps and sub-Bowman's keratomileusis (SBKM) that allow patients with thin corneas or are at risk for ectasia to have refractive surgery. Lamellar technology also continues to improve, with great interest in laser flaps and other femtosecond laser applications.



Baush & Lomb's Zyoptix Diagnostic Work Station



Nidek's OPD Scan II Wavefront Aberrometer

## New Intraocular Optics

We are presently witnessing the convergence of cataract and refractive surgery, facilitated by a combination of safer phacoemulsification techniques and technologies, precision biometry and an exciting array of new intraocular lenses (IOLs). Today, refractive lens surgeons are now in action offering cataract patients higher-quality, spectacle-free vision after cataract or lens removal.

## New Corneal and Anterior Segment Diagnostic Techniques

There are new diagnostic devices that will provide refractive surgeons with a wealth of new data about the anterior segment.

Newer anterior imaging devices are designed to take multiple cross-sectional images of the anterior segment of the eye, providing accurate data on corneal curvature and thickness, anterior chamber depth, pupil diameter and true net power of the cornea.

Refractive surgeons are currently exploring ways to utilize this new data. Applications include the pre- and postoperative evaluation of patients, calculation of IOL power for postrefractive surgery eyes, elucidation of topographically complex eyes, corneal hysteresis and resistance. All are decision-making and treatment planning tools.

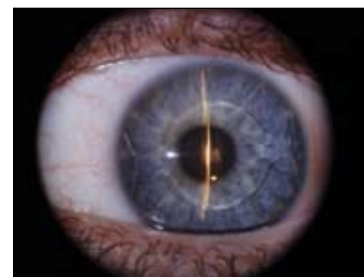
Diagnostic devices may provide insight into the relative advantages of surface, thin flap or traditional lamellar procedures. Some researchers believe that manipulation of corneal biomechanics may some day become a routine part of custom laser vision correction.

We are also on the cusp of major changes in how we measure and describe vision. Wavefront analysis first challenged the notion of 20/20 vision as “perfect vision.” We know now that an individual with 20/20 vision may still have significant visual distortions from higher-order refractive error, and better metrics are needed to quantify quality of vision and functional performance. Tests that can be used pre- and postoperatively to determine success include reading speed and other functional vision testing, as well as improved contrast sensitivity and acuity measures.

We still have much to learn about how to best utilize these devices and tests to make surgery safer and more precise. Without a doubt, however, they offer us powerful new methods for analysis in refractive surgery.

## Corneal Tissue Addition Technologies and New Corneal Transplants

Corneal tissue technologies represent a special new area of interest for the modern refractive surgeon. A completely new generation of synthetic inlays, ring segments and new corneal graft technologies is rapidly emerging.



Alcon AcrySof phakic anterior chamber implant



AMO Verisyse phakic implant



Intacs used for correction of keratoconus

Intacs intracorneal ring segments are used for the treatment of keratoconus, alone or in combination with a phakic IOL. Another option approved in Europe is made of PMMA ring segments implanted in the corneal stroma to regulate corneal deformities caused by tissue pathologies.

There are a number of medical devices under investigation that attempt to restore near vision through implantation of a central inlay or pinhole diaphragm that increases the depth of field.

Moreover, the use of these technologies combined with femtosecond lasers offer potential for refractive correction, as well as new alternatives for corneal transplantation.

Today, new corneal implants are promoted with refractive surgery tools such as the femtosecond laser. This emerging science will change the future practice of corneal transplantation, resulting in a new and better perspective on corneal surgery.

### Presbyopia and Accommodation

Effective presbyopia correction has long been considered the Holy Grail for refractive surgeons (and indeed, for the entire optics and vision correction field). The goal of presbyopia surgery is to restore near-vision performance, through either improved accommodative ability or pseudoaccommodation.

Corneal multifocality, IOL pseudoaccommodation by multifocality or partially accommodative lenses and the true restoration of accommodation are all fields of interest for modern refractive surgeons. While techniques such as intraocular lens multifocality are progressing today to standards where expectation of a reliable improvement in near vision is realistic, corneal multifocality techniques are presently opening a new alternative for near-vision restoration. In the meantime, research is under way for truly accommodative vision restoration. We anticipate that in the next five years, the restoration of accommodation will be a reality and effectively achieved.

In the meantime, many innovative technologies, a completely new body of scientific knowledge on the behavior of corneal and intraocular optics and the real mechanism of accommodation are progressing in a continual but fruitful debate.

Near-vision restoration will be accomplished very soon as different alternatives become available for surgeons and patients.

We are in the midst of an exciting time—a new environment for ophthalmic clinical science—in which improving the quality of vision and life for normal and visually disabled human beings offers more possibility than ever before, thanks to refractive surgery.

This is of paramount importance to the ISRS/AAO, a scientific society with an almost 30-year history of nurturing innovation and scientific advances in refractive surgery by offering anterior segment surgeons and other members around the world with unique educational programs and services that support the continued expansion of the scientific progress made by refractive surgery.



AMO ReZoom Implant



Alcon ReStor Implant