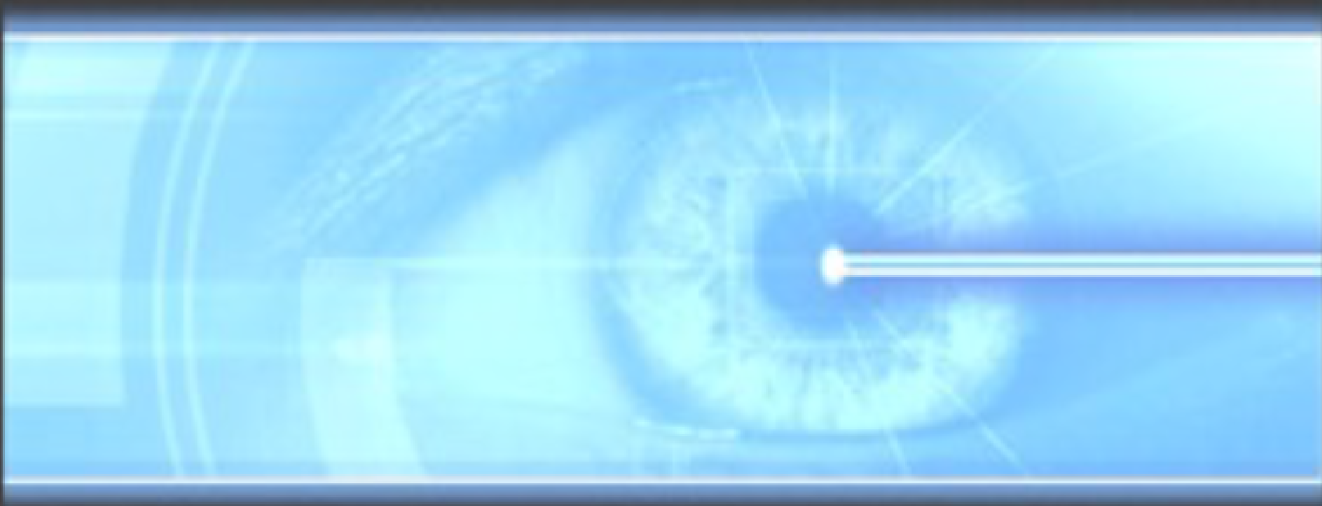
Advanced Refractive Surgery



A Comprehensive Patient Guide to
Advanced Refractive Surgery
from Custom *LASIK* to *Intacs*
to *Monovision* and *Multi-focal Lens*
Placement during Cataract Surgery

A. Ebbie Soroudi, MD,MS

Advanced Refractive Surgery

A Comprehensive Consumer Guide to Advanced Refractive Surgery: from Custom **LASIK** to **Intacs** to **Monovision** & **Multi-focal Lens Placement** during Cataract Surgery

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Table of Contents

Introduction and History

As an ophthalmologist specializing in refractive surgery, and as someone who has himself had "all-laser LASIK," I am always amazed to see how little people know when it comes to their options regarding laser vision correction. It is just as remarkable for me to see how so many people have just been truly mislead about refractive surgery and have very unnecessary fears and disproportionately unrealistic concerns.

The source of such misinformation is usually Optometrists who actively discourage their patients against refractive surgery for obvious business reasons, other doctors who have no clue what refractive surgery is all about, people who "have a friend who has a friend who had (cheap) LASIK somewhere and went blind," and last, but not least, from other (usually older) Ophthalmologists who have very little training in the field of refractive surgery.

This is a sub-specialty to which eye surgeons in residency, and even most post-doctoral fellows (let alone optometrists, internists, and other medical specialists), have minimal amount of exposure, and as such, their opinions about refractive surgery may not be based on experience and first-hand knowledge.

This combination of "lack of information" and "misinformation" is the most common cause of why so many people delay their decision to try to do something to be independent of their glasses, reading glasses, or contact lenses until they "just can't take it any more!" or until they get an ulcer from wearing their contacts so much that they no longer have a choice but to have surgery.

You see, glasses are just <u>not</u> an option for the millions of people who almost always "abuse" their contact lenses. They are truly "legally blind" without their contacts yet they don't even have a pair of glasses to their name: so they wear their contacts until they literally have to "yank" them out of their eyes just to replace them with a new one immediately after.

Some use their contacts till the last day, and call their optometrist/ophthalmologist to give them an "emergency" pair of contacts until they can get a new box (I myself used to be in this category when I was in medical school).

Some exercise and swim in their contacts, go to the Jacuzzi, steam room, and they sleep in their contacts. They call their "eye doctors" (often Optometrists) every year and get a renewal prescription (often) over the phone without a proper eye examination and life goes on until one of the two above scenarios take place: they either get an ulcer, or they "just can't take it anymore" as they've permanently damaged their corneas or developed an "allergic reaction" (Giant Papillary Conjunctivitis (GPC)), or keratoconjunctivitis.

If you are one of such people, sooner or later you WILL get a corneal ulcer and you just might PERMANENTLY damage your eyes.

I get frustrated to hearing these same people telling me, on a daily basis, how they "have been told" LASIK is so dangerous or how they can get an eye infection or go blind if they have LASIK surgery yet they have been truly abusing their contact lenses for decades and have incredibly poor "contact hygiene" with constant irritation, redness, tearing, and mucous discharge; it's not uncommon that I see patients who have even developed a brown ring around the edges of their contacts as a result of constant contact lens abuse, yet still they have been so "brainwashed" against any sort of surgical intervention.

One would be amazed to hear how many of these same people are brain surgeons, plastic surgeons, vascular surgeons, dentists, radiologists, photographers, videographers, movie editors, and artists who all have two important things in common: 1) they depend on their perfect vision to survive, and 2) they're all my own close friends, family members, and colleagues!

There is so much that can be done to not only help these types of people see perfectly without any need for glasses or contact lenses, but to also prevent them from needing a corneal transplant.

The reason I decided to write this book is to help relieve the unnecessary fears that are truly rampant among people wearing thick glasses, reading glasses, and strong contact lenses and to provide those who have been considering refractive surgery all the pros and cons about their options so that they can make a wise, "educated" decision.

Now, I am always the first person to say I would have to see something first in order to believe it, but as someone who has himself undergone LASIK surgery, I will not hesitate to tell you to believe it first, and you will SEE!

My hope is that with this book, I will help elucidate the facts behind the technology available today that can help those with even the most severe refractive errors to SAFELY become independent of their glasses, reading glasses, and contact lenses. I hope you will find this book useful, and I truly hope it'll serve as a catalyst for you to take the first important step toward living your life without the handicap of having poor "uncorrected" vision.

A. Ebbie Soroudi, MD, MS

I dedicate this book to my parents whose lives have always been completely devoted to helping me become a knowledgeable and caring physician, a skilled surgeon, and most of all, a decent human being. My success would never have been possible without their constant support.

History—Timeline of Cataract & Refractive Surgery

The study of visual problems (refractive errors) began in the early sixteenth century when Leonardo da Vinci contemplated the possible source of visual disturbances. A little later, in 1619, Scheiner measured the anterior surface of the cornea. His discoveries are still used by ophthalmologists today who recognize that refractive surgery often depends on changing the cornea's anterior contour. Removal of the natural human lens as a means of correcting high degrees of myopia was discussed by Boerhaave in 1746. But real progress in the field of vision correction was constrained until a better understanding of how the eye functions was acquired.

Johannes E. Purkinje observed in 1823 that images form on optical surfaces when they reflect external light. His observations led to the development of the Purkinje principles and the four Purkinje images. From these developments our modern day understanding of keratometry (measuring the curvature of the cornea) and theories of visual accommodation began to grow.

Several decades later came the advent of topical (eye drop) anesthesia, which led to cataract surgery after the Civil War. In 1867, with the development of the keratometer (an instrument for measuring the curvature of the cornea), surgeons could measure astigmatism following cataract surgery.

In 1869 Snellen (after whom the vision charts of today are named) proposed using incisions across the steep meridian of the cornea to flatten it and treat astigmatism. However, twenty-one years would pass before anyone (Galezowski) would actually attempt to flatten the corneal contour (albeit unsuccessfully).

Trials and Experimentation

Not long after a successful cataract surgery technique was developed by van Graefe in the 1850s, ophthalmologists everywhere began to recognize the impact of corneal shape on astigmatism. In 1895 Faber performed a full thickness corneal incision to decrease naturally occurring astigmatism in a nineteen year old patient, thus enabling him to pass his vision test for entrance into the Royal Military Academy. But all of these efforts were focused on astigmatism; no one looked beyond astigmatism to myopia or hyperopia. It soon became apparent that a better understanding of the principles of keratotomy (the making of incisions in the cornea) was needed before any further progress could be made.

It was about this time that a Dutch physician, Leendert Jan Lans (working at the time on his doctoral degree), began to systematically study and define the principles of keratotomy. So fundamental and comprehensive was his research that it soon became the standard of refractive surgery. He practiced and promoted the principles of corneal flattening that could be achieved by incisions made on the anterior surface of the cornea. By varying the number, direction, and shape of the incisions, Lans could manipulate the effects and tailor the visual correction.

In addition to surgical techniques, there were non-surgical attempts at reducing myopia by manipulating the shape of the eye. One remedy was an eye cup with a spring-powered mallet designed to flatten the cornea; another was a firm rubber band used to flatten it. But these were techniques that failed to result in any significant degree of visual correction.

With the exception of the work performed by Lans, 1885 to 1939, it was principally a time of trial and error for refractive surgery. Nevertheless, the successes and failures of this period helped determine which refractive procedures worked and which did not.

Modern Kerato-Refractive Surgery (Refractive Surgery Performed at the level of the Cornea)

In 1936 Tsutomu Sato observed a flattening of the cornea in patients who had sustained traumatic injury to the eyes. The corneas of these patients were irregular and abnormally steep (keratoconus) but flattened after episodes of corneal swelling. His work led numerous scientists to establish the value of radial keratotomy, built upon the principles outlined by Lans nearly half a century earlier and applied to the treatment of keratoconus corneas. Sato brought anterior and posterior keratotomy to clinical practice in hundreds of patients and reported his results in the early 1940s. Other ophthalmic surgeons subsequently used his technique and obtained similar results.

Sato also applied his posterior keratotomy technique to the correction of astigmatism; this technique involved the disruption of the corneal endothelium, the internal cells on the backside of the cornea. Unfortunately, the role of the corneal endothelium in maintaining corneal thickness and clarity was not fully understood in Sato's time, and the subsequent development of corneal swelling in the majority of his patients who received this treatment went undetected until after his death.

In 1948 Ridley, a physician to Royal Air Force pilots in World War II noted that pilots whose eyes harbored slivers of Perspex (cockpit "glass") seemed to have little or no reaction to this foreign material. This led him to suppose that a small lens made out of the same material could probably be tolerated inside the human eye. Soon he began experimenting with plastic lens designs, and the modern era of intraocular lens implantation for cataract surgery was born.

About the same time that Ridley envisioned the plastic intraocular implant, José Barraquer in Columbia developed the idea of lamellar (layered) corneal surgery to alter the shape of the cornea. He discovered that lamellar keratoplasty could flatten the cone of a keratoconus patient, significantly reducing myopia.

In 1949 Barraquer described the principles of lamellar surgery. He changed the cornea's shape by removing the anterior cornea (the equivalent of today's corneal flap) with an instrument called a microkeratome, freezing it, and changing its shape with a mechanical lathe called the cryolathe. In the mid-1980s the cryolathe rose to its highest state of precision through automation. In 1985 Casimir Swinger developed a method of changing the shape of the cornea without freezing it. He did this using the microkeratome only. Then in 1987 Luis Ruiz, a protégé of Barraquer, modified the principles of microkeratome corneal resection (cutting) and used an automated form of the instrument to perform the operation in situ (directly on the eye). This procedure, called automated lamellar keratoplasty (ALK), was used to correct high levels of myopia and hyperopia.

Halfway around the globe, a handful of Russian ophthalmologists began research to determine whether or not RK (radial keratotomy, or straight-line incisions placed in a spoke-like pattern around the periphery of the cornea) could be effective if it was confined to the anterior side of the cornea. This would thereby avoid the long-term problems that arose from the disruption of the corneal endothelium in Sato's posterior keratotomies.

By the mid-1970s, Russian scientists such as Durney, Yenaleyev, and Fyodorov had determined that most of the radial keratotomy flattening effect could be obtained with sixteen or fewer incisions placed only on the anterior cornea. Fyodorov developed a system of anterior radial keratotomy that, by varying the number of incisions and the amount of uncut clear central zones between them, permitted him to carefully control the degree of visual correction. It was he who convinced the world that radial keratotomy (RK) could indeed reduce or eliminate myopia.

Radial keratotomy was introduced into the United States in 1978 by Leo Bores. It soon became a subject of great interest and careful scientific scrutiny. In 1980 the National Institutes of Health sponsored the PERK (Prospective Evaluation of Radial Keratotomy) study which provided factual, scientific data on radial keratotomy performed in a standard manner in nine centers across the United States.

The Arrival of the Excimer Laser

The first step in the evolution of laser surgery occurred when experts researched the application of laser technology to vision correction. In 1980 Beckman and Peyman and their associates used a carbon dioxide laser to create thermal shrinkage of the cornea in order to change corneal contour. A year later in 1981 John Taboada reported at a meeting of the Aerospace Medical Association that the argon-fluoride excimer laser had the ability to indent eye tissue. Work then proceeded on ablation (microsurgical removal) of corneal tissue to flatten the cornea. Further evaluation was performed by Steve Trokel.

The first use of the excimer laser on blind human eyes took place in 1985 by Seiler in Germany. This was followed in 1987 in the United States. The procedure was called photorefractive keratectomy (PRK) and involved the ablation of the surface of the cornea to flatten its central portion in order to correct nearsightedness.

By 1990 and 1991, Pallikaris and Buratto and their associates had combined lamellar splitting (using the blade of a microkeratome to make a corneal flap, based on Barraquer's pioneering work forty years earlier) with excimer laser ablation of the exposed corneal bed.

It was Pallikaris who coined the term LASIK (laser insitu keratomileusis). This procedure took the moderately successful automated lamellar keratoplasty (ALK) procedure and added the incredible accuracy of the excimer laser to improve the results.

With LASIK, the realm of refractive surgery has been propelled into the space age dream of a nearly instantaneous, virtually discomfort free, refractive correction procedure, one that is literally sweeping the earth.

History Timeline of LASIK and Custom LASIK Surgery

- 1862 Topical eye anesthesia first used
- 1867 Keratometer developed measuring corneal Astigmatism.
- 1895 Faber performed first full thickness incision to correct astigmatism
- 1936 Sato of Japan did first radial keratotomies on back surface of cornea procedure, but later stopped due to poor results.
- 1948 Harold Ridley implanted first intraocular lens.
- 1949 José Barraquer of Columbia developed the first lamellar (layered) corneal surgery to alter the shape of the cornea. He used a micro-keratome to remove a flap tissue. He then froze it and changed the shape using a cryolathe. This lamellar surgery was an early forerunner to Lasik.
- 1970's Fyodorov et al developed radial keratotomy Soviet Union.
- 1978 Leo Bores performed first radial keratotomy in the United States.
- 1981 excimer laser developed

- 1985 micro-keratome refined by Swinger & Ruiz for lamellar surgery. ALK developed and performed immediate predecessor to LASIK.
- 1985 first excimer laser performed on human eye
- 1990 Pallikaris performs first LASIK procedure based on Barraquer work 40 years earlier.
- 1995 excimer laser approved by FDA in U.S. for low & moderate myopia
- 1997 excimer laser approved by FDA in U.S. for astigmatism
- 1998 excimer laser approved by FDA in U.S. for high myopia
- 1999 excimer laser approved by FDA in U.S. for farsightedness
- 2003 Custom Wavefront LASIK approved by FDA in U.S. for Custom LASIK procedures

Until now, miraculous advances have taken place to help our patients achieve excellent vision. Custom LASIK is the culmination of innovation, technology, and scientific insight. The future holds promise for many patients who today can't yet be helped with Custom LASIK, but this number is getting smaller and smaller by the day. The advances in vision correction will help those patients realize the dream of clear vision without glasses or contact lenses.

Chapter 1

Eye Anatomy and Function

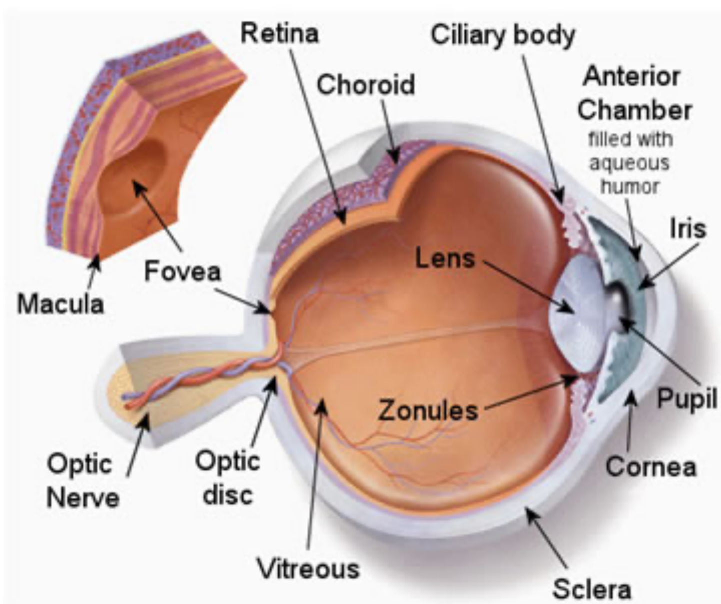
The first thing one should realize about vision is that we do NOT see with our eyes: the brain is what processes visual information and allows us to decipher the visual information that enters our eyes from different angles and a t different frequencies; our eyes themselves are just responsible for "gathering" this information and presenting it to the brain, nothing else.

It is not uncommon to see people who have beautiful, perfectly functioning eyes be completely blind as they've had a stroke or a brain tumor. So if one looks at vision this way, it's much easier to understand that the sole function of our eyes is to focus light that bounces off of the world around us onto the retina, which is a mere extension of our brain.

To this end, it would help to see the eye as a simple video camera. Oftentimes, when I'm trying to give my patients glasses (performing a "refraction"), I ask them to turn the knobs on the phoropter (which is just an instrument with multiple lenses built into it that help determine what power of the glasses one needs to see) until they can take a clear picture with their own eyes. By doing this, I literally ask them to take a picture with their OWN eyes as the camera for the moment.

So when the rays of light are not focused (or "refracted" properly) onto the back of the eye, one would have to either wear glasses, contact lenses, or have surgery to "redirect" the stray light and focus them onto the right spot on the retina (sort of like playing with a magnifying glass under the sun to focus all the light rays into a perfect bright "dot" of light or turning the lens of a camera to take a crisp, sharp picture.

The following images illustrate cross sectional images of the human eye, and below, I'll explain the function of the most "visually significant" structures and how they contribute to common clinical conditions that affect millions of people on a daily basis. Changing the "optical" properties of any of these structures can affect our ability to focus light tremendously.



The Human Eye

1. The Tear Layer:

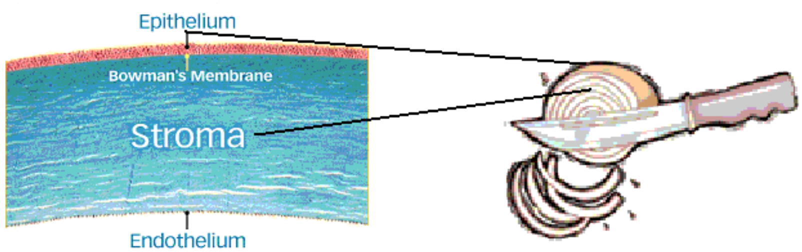
The moment we open our eyes (or blink), we cover our corneas with a very thin layer of oily tears (somewhat like a piston of an engine covers its walls with oil as it moves up and down), and we allow light to encounter this tear layer that sits on the surface of the cornea. This interface alone bends light tremendously and is THE MOST IMPORTANT part of the "optical system" of our eyes. As such, any irregularity at this level can be detrimental to one's visual acuity: anything as minor as a scratch on the center of the cornea to a bacterial infection (ulcer) to even dry eyes can seriously affect vision, and this is what makes my job very sensitive and interesting: it is at this level that corneal refractive surgery has its biggest impact.

2. The Cornea:

After going through the very thin tear layer, light traverses the corneal tissue itself, which can best be described as multiple layers of a slice through a white onion. It is remarkable to appreciate that the entire cornea is only about ½ of a millimeter (~540 micrometers) in thickness! Because kerato-refractive surgery takes place at this structure, I'll describe the cornea in more detail to help make sense of the difference between the different procedures available (e.g., PRK vs. LASIK):

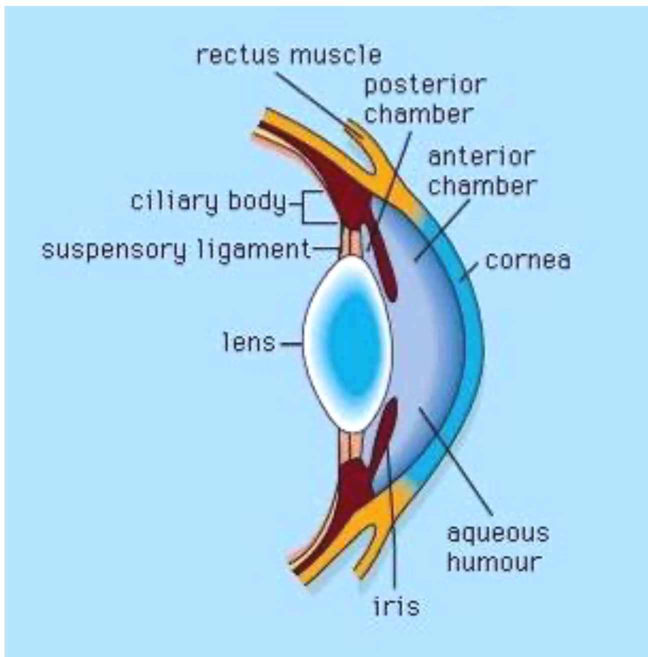
Under the microscope, the cornea has three basic layers: the first layer is the "skin of the cornea" called the epithelium. The epithelium is only 5 cell layers thin and covers the actual corneal tissue (called the "stroma") which comprises about 95% of the structure. The deepest layer of the cornea is called the "endothelium," which is basically comprised of one cell layer that coats the inside of the cornea; these cells are "pumps" that help keep the cornea clear and prevent it from swelling up and turning white.

In essence, the basic concept behind kerato (means Cornea)-refractive surgery is to reshape the "stroma" of the cornea to provide the correct optics for the eye to focus light onto the retina.



The figure above illustrates how the cornea is very similar to a cross-section through an onion with the epithelium being very similar to the "red skin" that covers it, the stroma being more like the onion layers itself, and the endothelium being very much like the thin skin that separates the onion layers (except unlike the onion, there's only one layer of endothelium that lines the inside of the cornea itself.

Multiple disease can affect how these layers are stacked on top of one another (trauma, infection (ulcers, Herpes, Syphilis), cataract surgery, pterygium (small fibrous red masses that grow onto the cornea)), and any irregularity or opacity at this level (especially if it is in the center of the cornea (visual axis) can seriously affect vision, and most often require corneal transplantation (which entails cutting out the scarred cornea with a "cookie-cutter," replacing it with a clear cornea from a cadaver, and stitching it in place).



Parts of the Anterior Segment of the Human Eye

3. The Anterior Chamber

After traversing the Cornea, light enters the "anterior chamber" of the eye which is filled with "filtered" water "Aqueous Humor" that keeps the eye formed and provides the inner layers of the cornea with nutrients and Oxygen (the tear layers does the same for the outer layers of the cornea). This liquid is constantly being replaced and refiltered (as in our kidneys), and it naturally provides a baseline pressure for our eyes (like the pressure of a water-balloon, for example). If elevated, high "intra-ocular pressure" (IOP) can seriously damage the Optic Nerve function (this condition is called "Glaucoma"). Just for the sake of completeness, the space behind the iris and in front of the lens is referred to the "posterior chamber," which is where this liquid is being released into the eye.

With trauma (and with a number of medical conditions), the anterior (and posterior) chamber can fill up with blood, and in the face of serve eye infection, it can be completely filled up with bacteria and pus; it is very important that this fluid remains clear, "quiet," and always at "physiologic" pressures (between 8-21mmHg).

4. The Iris

The iris serves as an aperture for the camera that dictates how much light should enter it: so when it's dark, the (radial) iris muscles (shaped like the petals of a daisy flower) contract to dilate the pupil (which is the opening of the aperture or the center of the daisy) in order to allow more light in, and when it's bright, the pupil gets smaller to limit too much light from entering it. It does this by constricting a round (sphincter) muscle that goes around the pupil like a rubber band. It is the iris that gives our eyes their brown, blue, or green color.

5. The Pupil

The (black) opening (aperture) through the iris is referred to as the pupils. It is generally understood that people with light color eyes (blue/green) usually have larger pupils and have more visual problems especially at night (as the pupils get even bigger in dim light conditions), and it is these people who often benefit most from "Custom" LASIK Surgery. This will be discussed in more detail in other chapters.

6. The Crystalline (natural) Lens

After traversing the Aqueous Humor, light goes through the pupil, enters the crystalline lens and bends again. The human lens is sort of like an M&M's Candy, except in place of the sugar coat on the outside, it is encapsulated by a thin, clear bag, and the chocolate part inside of it is made of soft, clear transparent protein molecules. Depending on the shape of the lens, it can bend light a lot, or not at all.

Just as in a camera, if one wants to take a picture of an image close by, s/he would have to use a thick "fat" lens to focus the light (this is called "accommodation"); this would not be necessary if we're taking pictures of images from far away. Our lens becomes "fatter" when we are reading (bends light more), and thinner when we are trying to see objects at a distance (doesn't bend light).

The ability of our natural lens to do this affords us near vision, and this lasts up to our mid 40's until it loses its ability to bend so much, at which point, we start needing reading glasses.

The eye does this by using the ("Ciliary") Muscles that are connected to the lens by multiple tiny cables (like a Trampoline) called Zonules (or suspensory ligaments). There is a whole chapter in this book that is devoted to near vision and near vision correction, and remembering the way our natural lens works is very important in understanding how we go about restoring near vision surgically.

Another important point about the crystalline lens is that it always gets opacified with age, multiple medical conditions, medications, and trauma; this is called a "Cataract." Everyone, at some point in their life gets Cataracts: it's very similar to getting white hair with age: it eventually catches up with us ALL.

It would be easy to imagine how even a small opacity in the lens in the path of the light ("visual axis") can affect vision so adversely, and it is not uncommon for people who even have a "speck" of cataract formation in the "right" (rather "wrong") place to be absolutely miserable with their vision and ask for surgery.

Cataract Surgery is the most commonly performed procedure in the world today, and is another level at which one's visual acuity can be easily modified (corrected) surgically ((lens-based refractive surgery) vs. corneal refractive surgery).

7. The Vitreous Cavity

After traversing the crystalline lens successfully, light goes through the "jelly" (Vitreous Humor) that fills the back of the eye. This Jelly is a very "sticky" viscous material that's encapsulated in a bag that is loosely connected to the retina (which is the film in the back of the eye). This structure is what's responsible for "floaters" that come about as some of the jelly material turns into liquid with age and as some of this material "clumps" together and floats in the visual axis (like fish swimming about in an aquarium). Floaters are mere shadows of these "clumps" and they become noticeable when they get close enough to the back of the eye as to cast a "shadow" over the retina.

Sometimes, this bag detaches from the Retina and leads to multiple bright flashes of light. This is very similar to what happens when somebody taps us right below our knees with a plastic hammer: the sudden pressure on the nerve there gets translated into electrical "action potentials," which leads into a knee-jerk reaction. The same holds true when this membrane peels off of the Retina: the sudden pressure on the nerves sets off multiple impulses on the nerves that get translated into bright flashes of light by the brain. This is usually a benign (and very common) occurrence, but it could be a sign of serious problems (namely, a detachment of the retina itself), and must be paid considerable (and immediate) attention to. It should be noted that floaters have nothing to do with LASIK or refractive surgery, and they certainly do not disappear after any sort of refractive surgery.

The other important point about the Vitreous Humor is that it can fill up with blood (called a Vitreous Hemorrhage), which can seriously affect one's vision. This is extremely common in diabetics and in patients with other severe retinal disease (such as retinal tears and detachments) and requires immediate attention by a capable Ophthalmologist who has the necessary tools (B-Scan Ultrasound) to see through the blood and treat any serious pathology on an emergency basis.

8. The Retina

The last (visually significant) structure in our visual pathway is the Retina which is a net of millions of brain cells (Neurons) that are arranged in sheets and line the back part of the eye like a rug; as mentioned earlier, these Neurons are extensions of the brain, and enter the eye through the Optic Nerve like multiple wires that go through a compact cable and splay out once they enter the eye.

The Retina is the "film" in the back of the camera: it translates light that's focused onto it into millions of electric signals which then go through multiple steps of processing by the retina itself, and by multiple parts of the brain as they travel all the way to the back of the brain. It has been estimated that more than 50% of the bulk of our brain is devoted to sight!

There is an intricate interplay of electrical signals that allows us the gift of sight, and it's easy to imagine how even a minute malfunction in any of these steps can be so detrimental to our vision, but assuming everything else is working properly, we still can not see well unless we have the ability to focus light correctly onto the back of the eye.

Chapter 2

Refractive Error

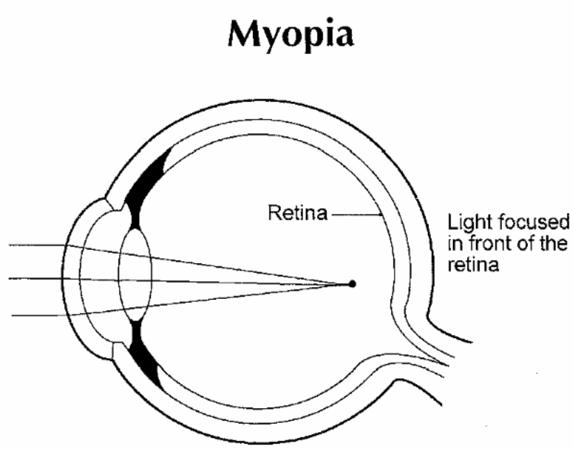
Just as if one is trying to take a picture of something with a conventional camera, the image has to be focused perfectly onto the film in order to take crisp, clear pictures. In this situation, the lens of the camera can be in either of three positions: either it's a) not turned enough to focus the image onto the film, b) it's turned "too much" so that it's "overshot" the image past the film, or c) it's focused perfectly onto the film (this is called emmetropia, and it is what we try to achieve with any type of refractive surgery).

Near-sightedness ("myopia")

When the lens is in its first position (turned "too much"), the image focuses in front of the film, so without the ability to turn the lens, in order to take a clear picture, one would have to bring the image closer to the camera so that the bent light rays in front of the film can move further back and fall onto the film itself: in other words, the camera "sees" images close up, but gets blurry the further the image moves.

This is EXACTLY what near-sightedness is all about: the eye is too long and/or the cornea is too powerful so it projects light in FRONT of the retina, and one would need a lens that is "skinny" in the center and thick on the periphery (concave lens) or a "minus" prescription in their glasses or contacts in order to see clearly.

Without correction, it sees images from close up, but is very blurry after a certain distance (which depends on the severity of their prescription): the higher the amount of myopia, the closer they would have to hold images in order to see them.

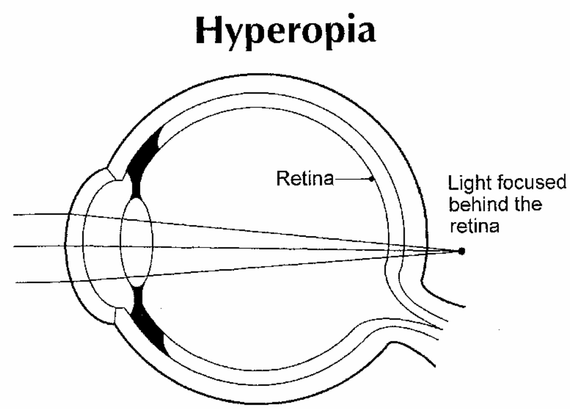


In myopia, nearsightedness, light rays focus in front of the retina, causing distant objects to appear blurry.

Far-sightedness ("Hyperopia")

The opposite applies in the second scenario. The lens of the camera is turned "too little" so that image focuses behind the film. Again, without the ability to turn the lens of the camera, in order to see, one has to place objects very far in order to see them; in other words, one has to "converge" these light rays with a convex lens (which is thick in the center, and thin in the periphery) in front of it as to allow it to take clear pictures.

This is exactly how a "hyperopic" or a "far-sighted" eye sees: the closer the images get to the eye itself, the further the light rays get from the film and the vision gets more and more blurry, so they can see images at far distances, but their near-vision is horrible.



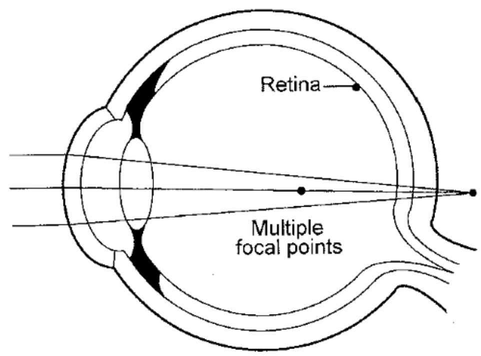
With hyperopia, farsightedness, light rays focus behind the retina. Objects in the distance are seen less blurry than near objects.

Now, these two scenarios illustrate the "basic" refractive errors (low order aberrations) a "typical" optical system can have, but the cornea is somewhat more complicated than that, and it has yet another dimension of refractive error that can not be explained as easily.

Astigmatism (pronounced "ə stig'mə tiz'əm")

The easiest way to make sense of this, in my opinion, is to imagine a magnifying glass being a perfectly round and regular glass lens that concentrates light from the sun onto a perfect "dot" of light. Now, imagine you heat up this lens over fire and stretch it in one direction so it looks more like an American Football: held under sunlight, this lens can never focus light onto a point, rather it focuses light into a "line" of light that points in the direction the lens is being held: this is what "astigmatism" is all about, and it prevents one from focusing light from either near or far, and it is a little more challenging to fix.

Astigmatism



In astigmatism, light entering the eyeball focuses on multiple areas rather than on the retina. Objects both far and near appear blurry.

In order to allow a magnifying glass that's been stretched into the shape of an American Football to focus, one would have to make another one just like it and place it on top of the first lens, except 90 degrees away: this focuses the light into a "cross" or a "+" sign, the center of which has the most "pixels" of light (called the circle of least confusion).

By combining this "cross" (which combines a "football-shaped glass" pointed in the right direction) with either a plus or minus lens, we can "land" the image on the retina and fix people's vision with glasses and contact lenses.

So if one looks at a typical prescription for glasses, s/he would find three numbers: the first determines the amount of near-sightedness or far-sightedness, the second number determines the amount of astigmatism, and the third number denotes the axis at which it should be held to best focus the light onto the retina.

Example

A prescription of +1.00 +2.00 axis 90 denotes 1.00 diopter of hyperopia, with 2.00 diopters of (hyperopic) astigmatism at the axis of 90 degrees (also known as "with the rule" astigmatism).

These two aspects of refractive error can correct anyone's vision to a perfect 20/20 (assuming the rest of the visual axis is clear and they have normal healthy eyes), and glasses can usually address these "lower order aberrations."

"Soft" contact lenses can easily treat between -11.00 Diopters of myopia up to +8.00 Diopters of hyperopia without astigmatism, and "toric" contact lenses can now correct up to 1.75 Diopters of astigmatism, and anything stronger than that usually requires the RGP (Rigid Gas Permeable) Contact Lenses.

But the human optical system is STILL more complicated than this, and there are other irregularities that glasses and contact lenses still can not address. Assuming these "lower order aberrations" are perfectly corrected, some people still complain of imperfect vision: they state they see "haloes," "glare," or just not "crisp" vision. Some complain that they see a "tail" on either side of bright lights at night, or see a "star" around car lights, while others explain in great detail how they see "rainbows." For the most part, these patients are not on hallucinogenic drugs, but they are explaining the effects of what's now known as "higher order aberrations."

In these patients' cases, their corneas are deformed in ways that they bend light somewhat irregularly so even with the best prescription of glasses, and even with 20/20 vision, they still complain of seeing "blurry" or "fuzzy." These are parameters that we can now effortlessly measure with a "wavefront" scan of the eye, and furthermore, they can be addressed using "custom" LASIK or "wavefront-guided" technology, and will be explained in future chapters.

Poor Near-Vision as a Result of the Normal Aging Process ("presbyopia")

Presbyopia (literally means "old eyes") occurs as the protein composition of the lens changes, making it harder and less flexible, and as a result, unable to "flex" enough to focus images from close up. It is thought that with time, the "cables" (zonules) that are attached to the lens also become more lax as well which further contributes to our inability to "flex" the lens. In essence, with age we start to become "far-sighted."

This is one of the most common complaints I have from my patients who are older than 40 years of age, and treating presbyopia certainly comprises the bulk of my refractive practice.

The onset of presbyopia typically occurs between the age of forty and fifty and continues to worsen up to the age of about 70, at which point it plateaus. When this occurs, people start to hold images further and further away so they can focus them and eventually start to require reading glasses. Even contact lens wearers will need reading glasses over their contacts when they reach their mid-40's.

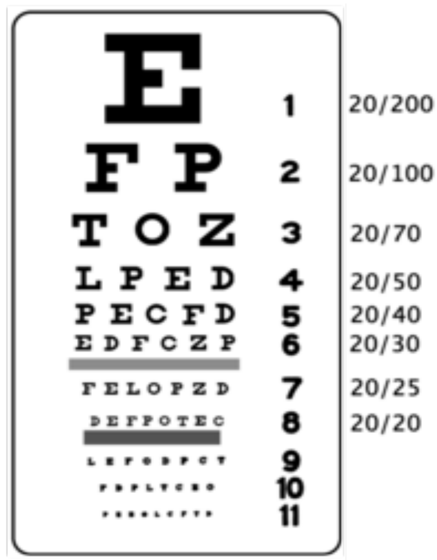
Today, people are living longer and healthier lives, and with the help of cosmetic surgical techniques, Botox, and fillers, people are looking younger than ever. The inherent discrepancy between the way people over 40 "look" and the way they "see" up close is a source of great annoyance: by having to bring out a pair of reading glasses just to read a menu at a restaurant, people who otherwise look like they're in their 20's suddenly "show" their real age.

In the hands of the right surgeon with experience in correcting presbyopia, there is so much that can be done to reverse this great nuisance for the millions of people who suffer from it on a daily basis.

So what does 20/20 stand for?

We often hear people say they see 20/20 or see advertisements "guaranteeing" 20/20 or your money back, but no one really explains what these numbers mean: this numbering system has been developed to measure one's "visual acuity."

It is very important to realize that it does NOT provide any information about anyone's refractive error, and it certainly doesn't quantify one's "vision" (which also entails their "fields of view," "brightness," "contrast sensitivity," "color perception," etc., but rather, it JUST measures what's the smallest letter they can distinguish at a certain distance from a standardized ("Snellen") chart.



Snellen chart. Illustration not intended for vision testing.

The number on top denotes the distance one has to stand away from the chart to see a standard sized letter. So if someone has "normal" vision, s/he would have to stand 20 feet away to see what another person with normal vision can see at a 20-foot distance (in this case, line 8). Someone with a visual acuity of 20/200 for example, needs to stand at 20 feet to see what another person with "normal" vision can distinguish at 200 feet (s/he therefore, has very poor visual acuity): 10 times worse than someone with 20/20 vision (200 divided by 20 = 10).

On the other hand, one with 20/10 vision can stand at 20 feet and still distinguish what someone with normal vision can only see at 10 feet: in other words, they can stand twice as far and/or see letters twice smaller than someone with "20/20" vision.

Just remember that the higher the denominator, the worse the visual acuity, and vice versa.

It is also very important to realize that these numbers do NOT have anything to do with your "refractive error" except that the higher the refractive error is, the lower one's visual acuity gets; in other words, they are inversely proportional.

Example:

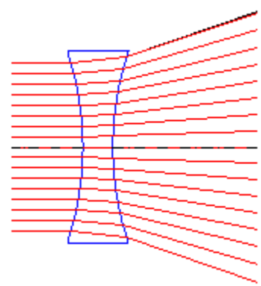
One may have a visual acuity of 20/60 with a refraction of -2.00 +3.00 x90 OR +3.00 -0.50 x20 OR -1.75 with no astigmatism at all: the refractive errors are completely different, yet the eyes can still distinguish the same sized letters. I often hear people tell me in conversations that they were told their "prescription" is 20/100, which is not an accurate statement, rather it just tells me how well (or poorly) they see without glasses: it does not tell me anything about their level of myopia, hyperopia, or astigmatism.

Measurement of Refractive Errors

So these (20/whatever) numbers basically quantify our visual acuity, but they do not provide any information about our refractive error.

Our refractive error is measured in diopters (D), which in simple mathematic terms equal to one over the distance at which we have to hold an image in order to see it (1/m). This is the number used to determine your refractive treatment.

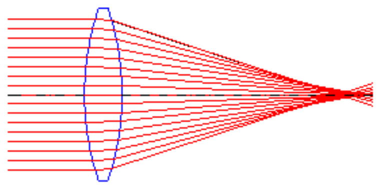
The more nearsighted or farsighted one is, the worse the vision, and the higher the prescription is in diopters. For example, a -2 Diopter myope can see images clearly up to 0.5m away (1/2D=0.5m), and starts to see blurry after that. A 2D hyperope can see images up to 1/2 m away, and anything closer they see blurry (unless they are accommodating).



Concave or Negative lenses will diverge (spread out) light rays

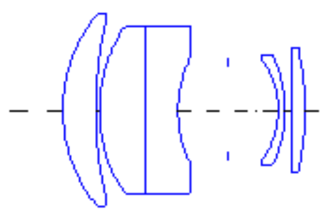
To refresh your memory, people that are nearsighted (myopic) can see close objects but distant objects are blurred. They require concave lenses in their glasses or contacts to diverge the light rays that are already bent too much by their eye. These refractive errors and corrective lenses are designated by a minus sign in front of the diopter power, for example -3.00 D.

People who are farsighted (hyperopic) are lacking refractive or light bending power in their eyes. This lack of refractive power focuses their image behind the retina. They require convex lenses to help converge light. These farsighted refractive errors and corrective lenses are designated by a plus sign in front of the diopter power for example +2.00 D.



Convex or Positive lenses will converge or focus light and can form an image

You can have mixed lens shapes too, especially if you wear bifocals, trifocals, or progressive glasses.



Mixed lens shapes

Chapter 3

Ancillary Tests One Must Have Prior to Refractive Surgery

Pachymetry

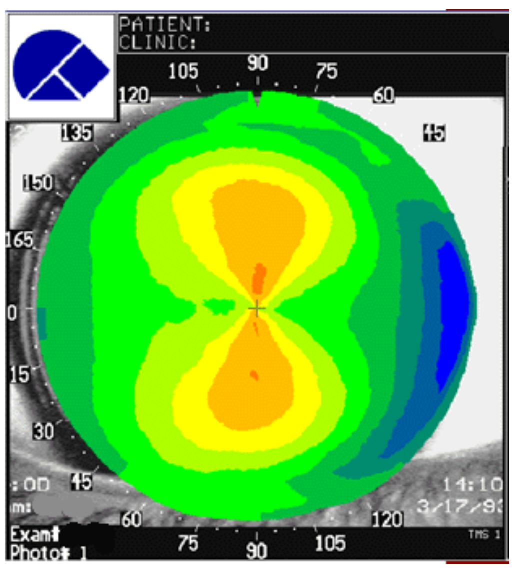
Due to the fact that the Cornea (the Corneal "Stroma") is ablated (literally shaved) with a laser in order to change its shape, it is imperative that we have a good idea "how much" tissue we have to work with before surgery. As mentioned previously, the thickness of a normal cornea is about 540 micrometers (roughly about half a millimeter). In order to prevent the cornea from thinning "too much" and losing its structural integrity, we would like to keep the "residual" corneal bed thicker than about 250 micrometers. Pachymetry provides us with a very accurate measurement of the central corneal thickness.

This measurement can also be obtained with a regular "pachymeter", an "Orb-Scan" (see below), or a Pentacam, all of which utilize ultrasound technology, or a Visante Anterior Segment Optical Coherence Tomographer (OCT), which uses confocal microscopy. This newest technology (OCT) provides the refractive surgeon with the ability to actually measure the thickness, regularity, and position of old LASIK flaps, which is a very useful information in those who have had LASIK surgery before and require touch-ups. These machines provide a more detailed "map" of the corneal thickness in different areas of the cornea (vs. just in one part as in with normal Pachymeters).

In the face of very thin corneas, it is contra-indicated to perform any sort of laser vision corrective surgery, again, especially if the "residual corneal bed" will be less than about 250 micrometers in thickness after surgery.

Corneal Topography

Just as if one is sitting in a satellite looking down on planet earth, the corneal topographer provides a map of the surface of the cornea. Please refer to the photo below which depicts the corneal topography of a patient with "regular" astigmatism (you will (and MUST) have this scan before you undergo any form of refractive surgery). On these images, the flat parts of the cornea (usually the periphery) appear blue (like the ocean), the "golf courses" appear green, and the hills and mountains are yellow, brown, and red depending on their "steepness." Corneal topography not only reveals the amount, direction, and the exact location of one's corneal astigmatism, but it also provides the surgeon with an idea of how "regular" their patients' corneas are. In the face of any irregularity ("ectasia"), laser refractive surgery is usually contra-indicated.



Wavefront Analysis

Wavefront analysis is a method of objectively quantifying all the aberrations of the eye. It was originally applied to telescopes used by astronomers in the 1960s to help resolve distant stars. Refractive surgery was the catalyst that helped wavefront move into eye care. Wavefront analysis opens the door for measuring formerly inaccessible elements ("higher order aberrations") that impact vision so that we can apply new corrective treatments.

Wavefront "aberrometers" capture these higher- and lower-order irregularities that are unique to each patient's eye. We "transfer" this information to the "excimer" laser, where it is computer-matched to create the precise ablation required in customized laser eye surgery.

Wavefront analysis allows us to measure higher-order aberrations, which represent about 20% of a typical eye's total optical aberrations (in some patients, such as those with keratoconus, higher-order aberrations can represent the majority of optical aberrations).

Almost every major excimer laser manufacturer in the international market now has a wavefront analyzer for refractive surgery. Wavefront-driven treatments have significantly improved contrast sensitivity and night vision over standard methods. Coupled with the wavefront measuring device, we are now able to customized laser eye surgery, guaranteeing more clear vision for our patients.

Orb-Scan Technology

The Bausch & Lomb Orbscan IIz topographer allows us to analyze the physical shape and contour of patients' corneas and allows us to decide if it has a suitable shape, is healthy and thick enough for treatment.

It is the only topographer currently available that measures the shape of both the front and back surface of the entire cornea (other systems only measure the front surface) and can therefore provide a complete picture of the thickness of cornea (this is a very useful tool to diagnose "sub-clinical" (called "Form Fruste") ectasias, thereby preventing complications.

The Orbscan captures data within seconds from 9000 points on the cornea during each measurement. It is, in my opinion, a very important exam in anyone considering laser vision corrective surgery. Please note that one Orbscan image provides the surgeon with a very detailed Corneal Topographic image, as well as a Pachymetry map, minimizing the number of tests one needs prior to surgery.

Non-surgical Vision Correction Options

Before considering laser vision correction, I always recommend that you review the variety of different non-surgical ways refractive disorders can be corrected. All have benefits and drawbacks, and what I often tell my patients is: "if glasses or contacts don't bother you, do NOT do surgery." This is NOT because I don't feel refractive surgery, in the right hands, and with the best technology, is extremely safe, but I just feel that if "something ain't broke, one shouldn't try to fix it." I should mention here that the only people I have ever met who have not been ecstatic with their surgery have been those who were "perfectly" happy with their glasses. The thing is, it is extremely rare for anyone to actually "enjoy" wearing glasses or contacts (unless they're color contacts).

There are two additional things I always remind my patients who would like to consider "non-surgical" approaches: 1) you would most-likely end up spending more money in the long-run on glasses and contact lenses than if you have surgery and never have to buy another pair of glasses or contacts ever again, and 2) the "freedom" from visual aids (glasses or contacts) provides for such improvement in people's lifestyles that is truly "out-of-proportion" to the cost of the "surgical" approach.

Glasses

Glasses are certainly the easiest and safest way to go about correcting one's visual acuity. They are affordable (unless you buy multiple pairs of designer frames), easy to maintain, and versatile. They may restrict peripheral vision, be difficult to wear in certain weather conditions and situations, cause images to appear smaller than what they really are, cause a number of visual aberrations (including halos around lights), and have a limited usage life. They may interfere with certain occupations and recreational activities, and some people don't like the cosmetic impact on their appearance. Some people have concerns about safety in an emergency if their glasses are lost or broken. In addition, people who have a big discrepancy in their refractive error between their eyes (usually >2D difference) can not tolerate wearing glasses, which is a problem we can easily fix with contact lenses or refractive surgery.

Contact Lenses

Contact lenses are another common solution for the correction of refractive visual problems. Advantages include clearer, more natural vision (than glasses), no change in cosmetic appearance, more freedom in recreational activities, and better peripheral vision. On the other hand, contacts are high maintenance, may get lost, are less comfortable for patients with dry eyes, may cause visual aberrations (including halos and fluctuating vision), and always carry an increased risk of infection and possible corneal scarring. In higher altitudes many adults become intolerant of contact lenses over time because of dry climate and decreased oxygen in the air.

There are many types of contact lenses available today and the vast majority of people may be fit comfortably, regardless of their level of nearsightedness, farsightedness, or astigmatism.

Orthokeratology

This is a technique that uses a series of rigid contact lenses to flatten your cornea to treat myopia. The effects are not permanent and require continued dependence on part-time retainer lenses. The technique is high maintenance and requires continuous follow-up visits. The long term effects may also lead to permanently warped corneas. The risk of keratitis or infection is also considerably increased over normal contact lens wear. I do NOT recommend this treatment for anyone.

Chapter 4

Refractive Surgical Procedures

In some parts of the world, the incidence of nearsightedness is close to fifty percent. In the United States alone, as many as seventy-five million people are afflicted with myopia. Additional estimates by the National Institutes of Health report that as many as one adult in four suffers from myopia. The development of a laser surgical procedure to correct nearsightedness, farsightedness, and astigmatism that is both predictable and relatively safe came into its own in the latter part of the 80's and early 90's.

Surgical Procedures

Below is a list of some of the surgical refractive procedures performed today:

1. Cataract surgery with intraocular lens implantation
2. Laser in-situ keratomileusis (LASIK)
3. Photorefractive keratectomy (PRK)
4. Intacs™ corneal ring segments
5. Implantable Lenses (Phakic IOLs)
6. Clear lens extraction (CLE)
7. LASEK (Laser Epithelial Keratomileusis)
8. Conductive Keratoplasty (CK)

9. Laser Thermal Keratoplasty (LTK)
10. Astigmatic keratotomy (AK)

I hear, almost daily, from my patients that they have been told they're "not a candidate" for refractive surgery. From the list above, procedures 1-6 are, in my professional opinion, the safest and most effective, and will take care almost **100%** of any patient's needs: if one is not a candidate for any of these procedures, s/he should NOT have refractive surgery.

The names of these procedures may be hard to pronounce, but the results in correcting poor vision due to refractive errors have been excellent. The high rates of success reported with these procedures—and Custom Lasik in particular—have lead to their widespread acceptance within the ophthalmic community and among patients. Which procedure is right for you will depend on multiple variables:

- **Your prescription** (I have personally, successfully, performed refractive surgery on patients with prescriptions as low as -20D of myopia and as high as +11D of hyperopia, but with LASIK per se, I do not recommend treatments beyond +6D of hyperopia, -12D of myopia, or anything exceeding 7D of astigmatism with LASIK).

- **Your corneal thickness and shape** (as long as the "residual corneal thickness" after LASIK surgery remains above 250um, and there is no evidence of any corneal ectasia (e.g., early keratoconus) on corneal topography (or Orb-Scan or Pentacam), LASIK surgery has been found to be extremely safe).

- **Your age** (I have safely and successfully treated patients as early as 11 years, to as late as 91 years of age with refractive surgery. Although the available FDA data does not precede 18 years of age, this does not imply that LASIK would be unsafe for younger patients, but there is just no long-term data yet available for these patients). Realizing this, I routinely perform refractive surgery on patients younger than 18, with the patients' and the parents' understanding that it is done for those who have no other options to see better but to have refractive surgery).

    - Example 1: an 11-year-old boy with a history of trauma to one eye as a child, has developed 4D of astigmatism in the affected eye. He is intolerant of RGP contact lenses, and is seeing 20/100 without correction. After LASIK, he is seeing 20/20 with no correction at all.

    - Example 2: a 12-year-old boy with severe myopia (-11D) and Nystagmus (constant irregular eye movements since birth), unable to use contact lenses and has very poor vision with his glasses (20/400). After LASIK, he is seeing 20/60 with no glasses at all (this is the best visual potential his eyes have, otherwise, he should see 20/20.)

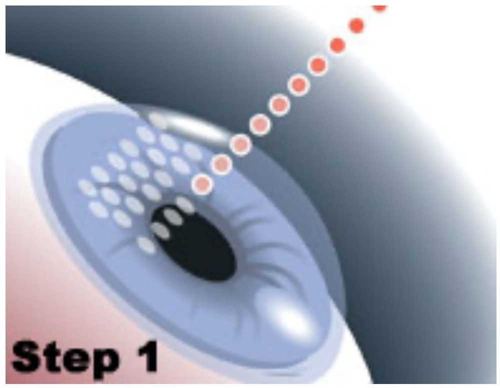
- **Your eye health** (There are multiple eye conditions (besides corneal ectasias such as keratoconus or pellucid marginal degeneration) that serve as contra-indications for LASIK surgery. For the most part, these are retinal disease (such as diabetic conditions, macular degeneration, or hereditary retinal disease), but assuming these conditions are stable, and the patient's vision improves with glasses, LASIK (or other forms of refractive surgery) would really benefit these patients. I have personally treated a number of patients with Retinitis Pigmentosa with great success. With underlying eye disease, the decision to perform refractive surgery should be left to the discretion of your refractive surgery specialist.

Laser in-situ keratomileusis (LASIK)

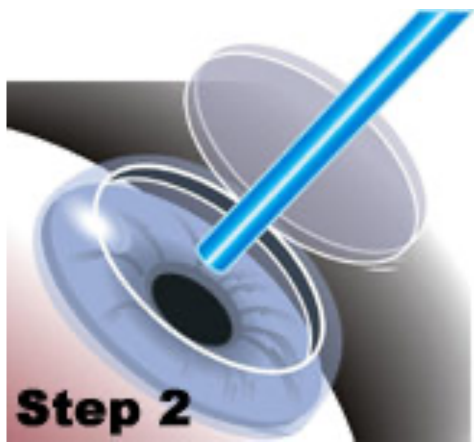
Conceptually, LASIK is a very simple surgical procedure that involves two steps: cutting and lifting a small "contact lens-like" flap from a thin superficial layer of the cornea (about 100-120um in thickness), followed by laser reshaping of the underlying corneal tissue to correct the refractive error.

The formation of the flap is traditionally done with a sharp mechanical bladed device, called a microkeratome. Today, the use of the microkeratome is slowly losing its popularity to the "intralase" technology, which instead of a sharp blade, utilizes a laser that allows us to cut a perferctly shaped and sized flap using millions of tiny air bubbles. The use of this technology allows us to do what's also known as "all-laser LASIK." (This is the ONLY technology I use to treat my patients: it allows me to customize my flaps shape, size, thickness and location, and provides my patients with a much higher level of security and safety.) Furthermore, intralase makes this procedure more "automated" and minimizes the dependence of this procedure's outcome on the surgeons' manual dexterity, which in some cases, is extremely helpful…

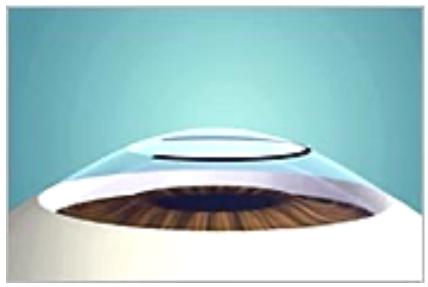
Following lifting the flap, a computer controlled excimer laser delivers pulses of cool ultraviolet light to underlying corneal tissue, ablating or "evaporating" microscopic layers of the cornea. Once the reshaping is done, the flap is folded back on the eye where it self-seals within seconds. The entire procedure takes approximately a few minutes per eye.



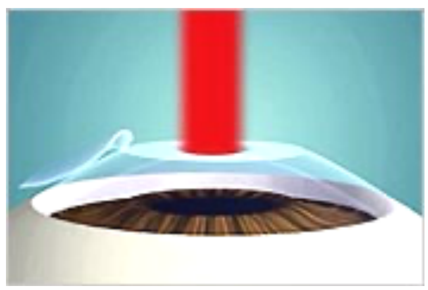
Intralase bubbles are created within the Corneal Stroma at a pre-designated depth (90-120µm) at a rate of 60,000 beats per second, and the edges of the found (hinged) flap are carved using the same laser.



The LASIK Flap is gently lifted using a small hook



On the surface of the eye (cornea), a thin flap is created.



Computer assisted, the eye surgeon releases laser energy to reshape the cornea.

Once reshaped, the flap is replaced and the body seals it shut or rapid recovery of much improved vision

Photorefractive Keratotomy (PRK), AKA, Advanced Surface Ablation, AKA, "flapless" LASIK

PRK was the first FDA approved laser refractive procedure, and in my opinion, still the **safest** way to perform keratorefractive surgery. During this procedure, the surgeon uses the same excimer laser as used for LASIK cases to reshape the outer surface of the cornea. (If you haven't done so yet, please see the description of the layers of the cornea in the anatomy section of this book. It will make the following explanation much simpler). Unlike LASIK however, no flap is created with PRK; instead, the very thin (5um) epithelium covering the cornea (the skin of the cornea) is gently peeled away using either a brush or a mild alcohol solution to loosen these cells (this makes the cells "drunk" and much easier to gently peel away).

The reshaping (excimer) laser is then applied directly to the surface of the cornea. Often, the wavefront map of your vision is used to guide the laser treatment, just as in the second step of LASIK.

With PRK, the results are identical to (if not better than) LASIK, but vision recovers slower, and because the epithelium has been removed, depending on the patient, there is some irritation and pain until these cells grow back, which usually takes about 4-7 days.

Generally, this technique is reserved for patients who have thin corneas, are apprehensive about LASIK, or have a history of other refractive procedures. Your eye surgeon can advise you accordingly.

With the older, less sophisticated lasers (e.g., the Nidek), when higher refractive errors were corrected e.g. > 5 diopters, there used to be a small risk of corneal haze after the eye healed which slowly resolved over time. The application of an anti-fibrotic medication Mitomycin-C has been found to reduce the risk of haze formation. It is applied to the treated area for about 15 seconds.

With the newer "flying spot" lasers and with the new treatments algorithms, this post-operative haze is really a thing of the past, but most surgeons (including myself) still use Mitomycin-C in patients requiring treatments over -5 to -6 Diopters. In my experience, there is no difference in the amount of haze formation with or without mitomycin-C, and I've treated up to a -11D of myopia without Mitomycin with no haze formation whatsoever, but its use in high myopes is, at least conceptually, not a bad idea.

There is some controversy about using "chilled" irrigating solution or using a Balanced Salt Solution "popsicle" to cool the cornea after PRK in order to prevent haze and post-operative discomfort, but at least anecdotally, this seems to help patients, and I routinely "chill" the eye with BSS before I instill antibiotic (Zymar or Vigamox), and an anti-inflammatory drop (Acular LS), and place the "bandage" contact lens.

LASEK (Laser epithelial keratomileusis)

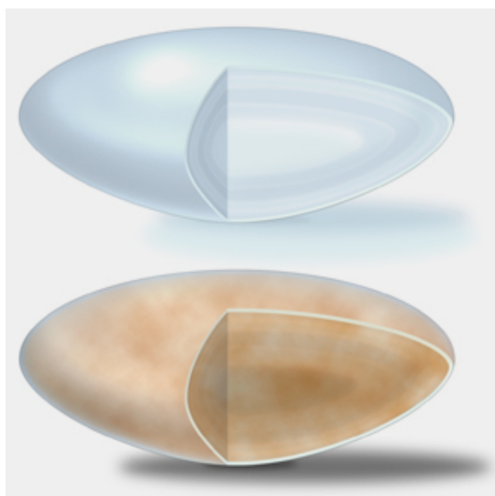
LASEK is a procedure identical to PRK but here the epithelium is removed from the surface as a very thin flap (epithelium only, no stroma), the laser is applied and then the epithelium is replaced. It has been thought that this procedure is less bothersome to patients as PRK, but in reality, it has not been found to be any better than PRK, and as such has largely been abandoned.

As with any treatment regimen, I always feel that patients are more likely to adhere to a simple, regular post-operative medication plan, and to this end, I usually keep my patients on a 4^{th}-generation fluoroquinolone (Zymar/Vigamox), an anti-inflammatory (Acular LS), and a steroid (Lotemax or Prednisolone) four times daily for a week, and I alter this depending on the patient's clinical picture (e.g., excessive inflammation).

Chapter 5

Cataract Surgery with Intraocular Lens Implantation

As part of the aging process, the crystalline lens gets cloudy, thus interfering with distance or near vision.

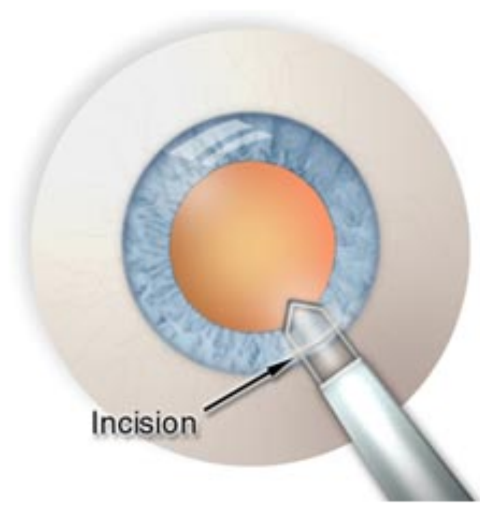


Normal lens (top) vs. a Cataractous (opacified) lens (below)

The surgeon can replace the cloudy lens with a clear plastic lens which is also designed to correct nearsightedness or farsightedness. Significant advances in cataract surgery have also brought us lenses that can help elderly patients see well for far and near, thus reducing dependence on both distance and reading glasses.

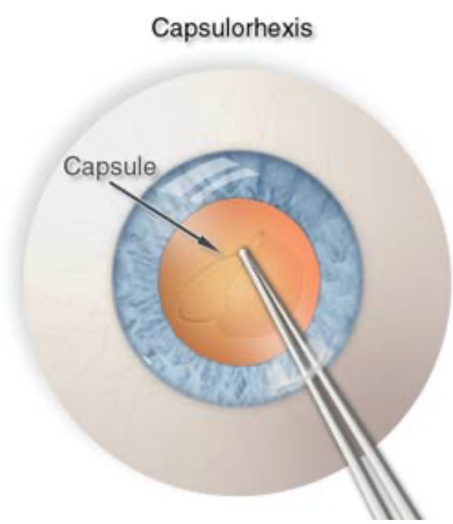
Modern technology allows the advanced surgeons to do this entire operation under TOPICAL anesthesia only (in the form of eye drops). This means, there will be no need for general sedation and no need for painful and dangerous injections to anesthetize the eye (which is STILL rampant among older Ophthalmologists not trained to operate under topical anesthesia).

To this end, depending on the level of your surgeon's skill, preference, and comfort, a small incision (as tiny as 2.2mm, up to 3.0mm) is made in the clear cornea (see the anatomy section) using a very sharp metal or diamond blade. Another very small (1mm incision is made in the clear cornea to allow the insertion of a small (assistant) hook in the eye to help move the lens around with the other hand.

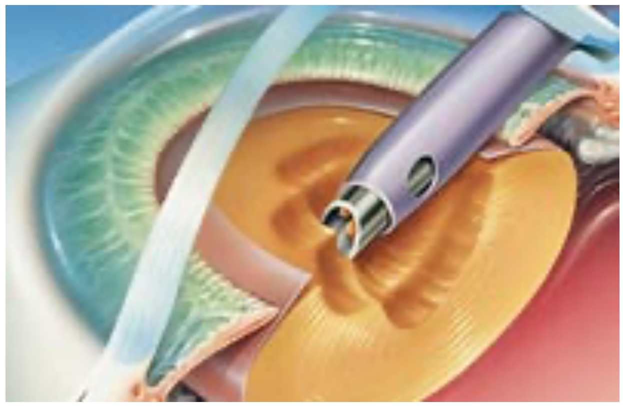


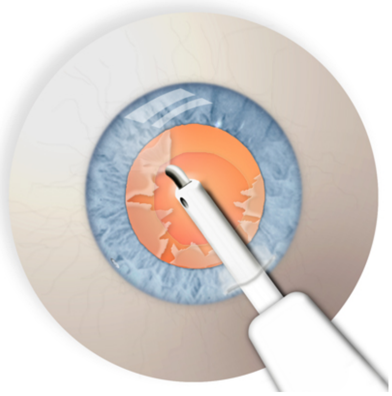
The anterior chamber is irrigated with 1% Lidocaine solution for pain control, and the inside of the eye is filled with a viscous ("honey-like) liquid (visco-elastic) to prevent the eye from collapsing.

At this point, the front part of the capsule that contains the lens is gently peeled using small foreceps through the tiny 2.2-3.0mm incision (this step is called the capsulorhexis), and the lens is "mobilized" in its bag by irrigating it with a "balanced salt solution" (BSS).

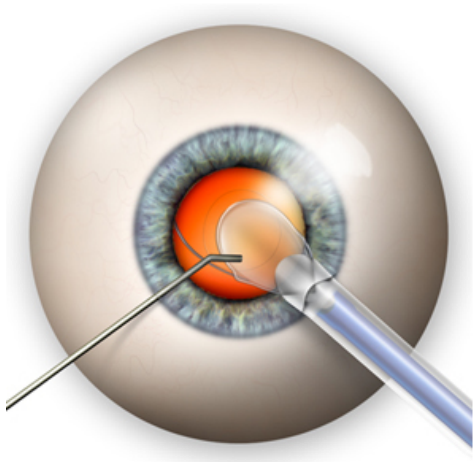


At this point, a small metal "straw" hooked up to a vacuum is inserted inside the small incision (a phaco-emulsifier). This "straw" has a vibrating (ultrasonic) tip that breaks the lens down while the vacuum "sucks" the lens particles out of the bag.





Once removed, a small, round, clear plastic lens is inserted through the small incicion into the capsular bag by folding it in the shape of a "taco" which unfolds into a plate once inside the eye.

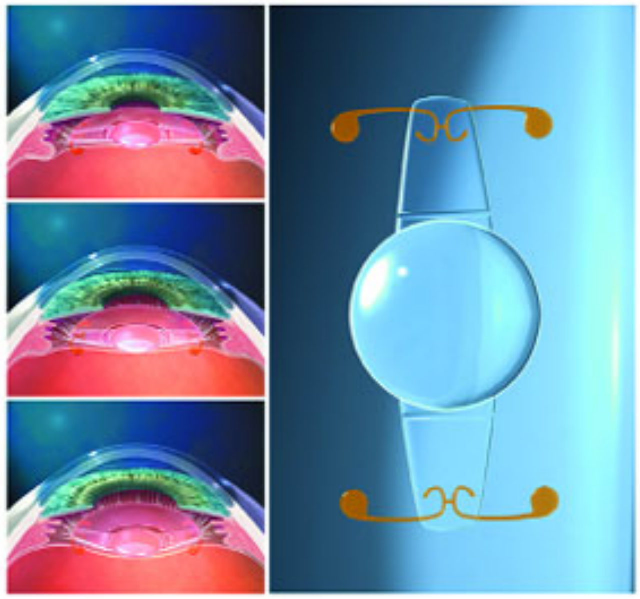


Traditionally the intraocular lens is monofocal or fixed-focus, which would allow you to see clearly for distance, but with these lenses, you will require reading glasses for close work.

In order to avoid having to use reading glasses after cataract surgery, there are two options available to you: 1) employ monovision, where your "dominant eye" would be corrected to see far, and your "non-dominant eye" would be corrected for near vision (please refer to the presbyopia section of this book for further details on monivision, it's pros, and cons), and 2) you can elect to have your surgeon place a multi-focal lens inside your eyes, so you can see at near AND at distance out of each eye independently. The latter is, by far, a better procedure and I recommend this to all my cataract patients.

There are a number of companies currently manufacturing presbyia correcting intra-ocular lenses (IOLs), but, in my professional opinion, there are two lenses which are currently the best available on the market: 1) the ReTOR multifocal lens, and 2) the Crystalens Accomodating IOL.

The Restor® lens (L) and magnified ®



Both of these lenses are approved by the FDA
and provide outstanding near and distance vision.

Personally, I perform more ReSTOR operations as I have found my patients benefit from better near visual acuity with this lens than the Crystalens patients. In some patients, however, I place a Crystalens in their dominant eye and a ReSTOR in their non-dominant eye. Because the Crystalens provides better "intermediate" vision than the RsTOR (for seeing things without having to get really close to them), I find this combination to work well in certain patients. Considering this "mixing and matching" is still a relatively new practice among "refractive cataract surgeons," I highly recommend you discuss these options with your own ophthalmologist prior to your procedure, preferably one who actually knows how to implant BOTH lenses, and has had experience doing this. I must add that, unfortunately, surgeons who fit this category are still quite rare.

This procedure is performed in an outpatient basis and in the right hands, should not take more than about 20 minutes.

It is extremely important that your surgeon has the right equipment to correctly calculate the power of the lens s/he implants in your eyes. To this end, it is imperative that they use either an accurate "A-Scan" ultrasound and/or an "IOL-master" device to choose a perfect matching lens for your eye's size and optics. In my practice, I obtain BOTH A-scan AND IOL-master measurements, and compare the data from both machines to have a perfect match every single time.

Also, it is important that your surgeon corrects all of your astigmatism to provide you with the best visual outcomes. I routinely do this by performing a "limbal relaxing incision" (LRI) (see below) at the time of surgery for those with less than 2D of astigmatism, or either LASIK or PRK post-operatively in those with more than 2D of astigmatism.

The better the optics of the eye, the better your visual acuity will be after the surgery. Please make sure your surgeon is knowledgeable and experienced to perform these operations if you want to be independent of glasses after your cataract surgery.

Chapter 6

Clear Lens Extraction (CLE)

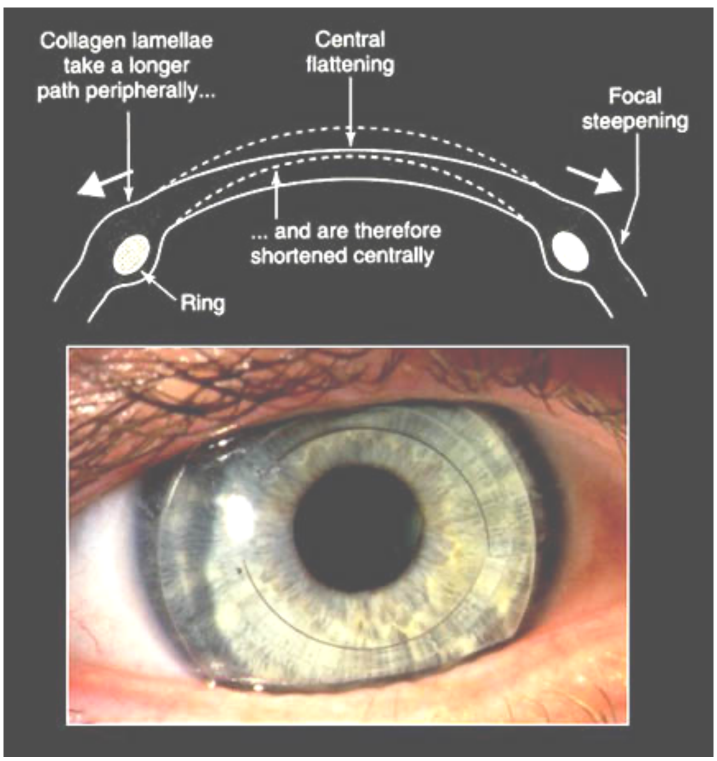
Clear lens extraction is recommended for patients who do not qualify for LASIK due to severe farsightedness, nearsightedness, thin corneas, or cataract formation. With CLE, the patient's natural crystalline lens is removed and replaced with a special intraocular lens similar to cataract surgery.

Astigmatic Keratotomy (AK), AKA, Limbal Relaxing Incision (LRI):

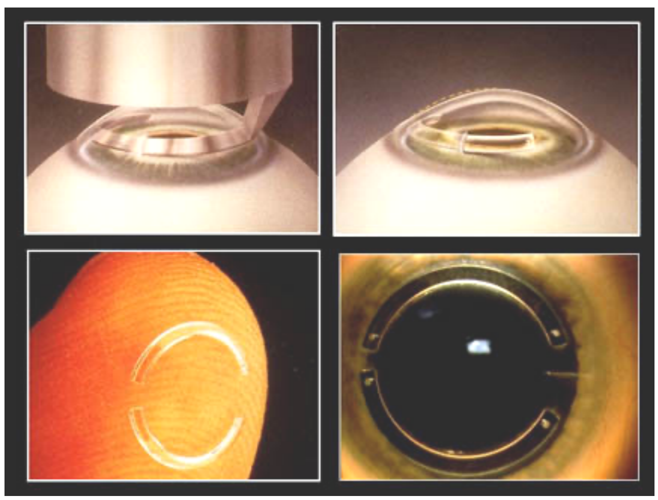
With Astigmatic Keratotomy, the surgeon places one or two partial-thickness incisions at the periphery of the cornea to relax it into a more spherical shape. AK is typically performed in conjunction with another eye surgery, such as cataract surgery. This very simple procedure, in the right hands, can correct up to 2D of astigmatism at the time of cataract surgery, and is a great way to reduce people's dependence on glasses after cataract surgery. I routinely perform LRIs for my patients intraoperatively. AK may also be performed after a corneal transplant. Although astigmatism can be easily treated with Custom LASIK, I avoid having to use LASIK or PRK on my cataract patients unless I can't adequately treat their astigmatism with LRI's (i.e., they have more than 2D of astigmatism), in which case I either perform LASIK or PRK to treat them postoperatively.

Intacs

Intacs are tiny clear inserts that are placed inside very small round tunnels that we make in the periphery of the cornea, deep into the actual corneal stroma encircling the pupils. By doing this, we have the ability to flatten the cornea considerably and treat myopes with extremely thin corneas or those with severe corneal ectasias (keratoconus, pellicuid marginal degeneration, or post-lasik ectasias) see much better without the need for a corneal transplant.



There are two ways to open the tunnels where intacs are placed: just like with LASIK, one can use a special blade to do it, or use the intralase laser, which makes these tunnels with bubbles. Again, just as with LASIK, I only use the intralase to make my tunnels for intacs as this provides me with the control I need to make my tunnels where I choose and at the depth I feel would work best (400um deep).



The creation and placement of the intacs rings using the prolate system

Although this procedure is extremely safe and effective, it is very important to choose the right patient for this technology, especially in those with corneal ectasias) as it is not as effective in those with really severe keratoconus with extremely steep corneas and in those with high myopia and "central cones."

As a patient, you should be very careful about who you choose to perform this surgery as there is a huge learning curve with this surgery as far as what size rings to use and where exactly to place them. There are NOT that many surgeons who are trained to use this technology, and if they are, they really haven't done that many. As of the time of this publication, I'm the second busiest intacs surgeon in California

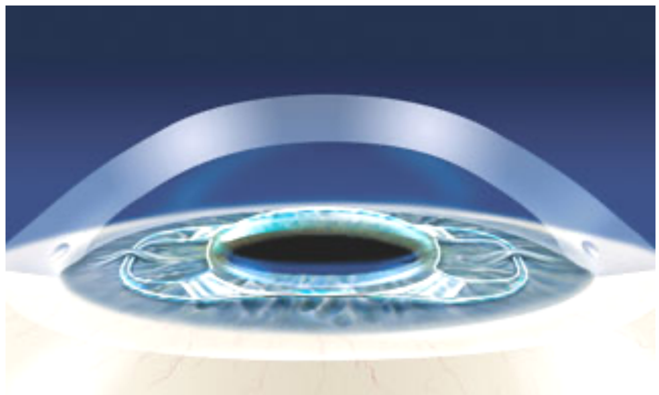
Implantable Contact Lenses (Phakic IOLs)

Unlike wearing a regular contact lens on the outside of the cornea, with the implantable contact lens, an ultra thin lens, designed to correct nearsightedness or farsightedness, is permanently placed behind the cornea. This procedure is not for everyone. It is indicated for patients with extreme nearsightedness (>-12D). For select patients, it works exceptionally well. Your surgeon will direct you accordingly.

Currently, there are two technologies available: Verisyse, and ICLs. I prefer the latter for my patients due to their ease of placement, and lower risk of post-operative complications.

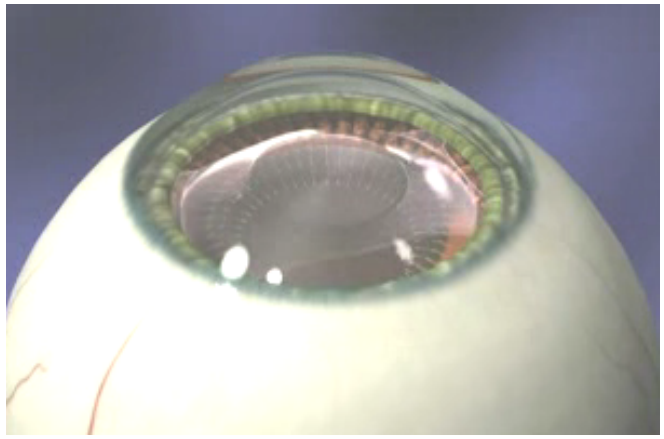
Verisyse

Verisyse lenses have been in use for over 18 years of use and more than 150,000 procedures have been performed worldwide. Verisyse lenses are safe and effective for very nearsighted people who are tired of thick glasses and are not candidates for Custom LASIK. The Verisyse™ Phakic IOL is surgically placed on top of the iris, which gives the eye another focusing lensThis procedure is reversible if desired.



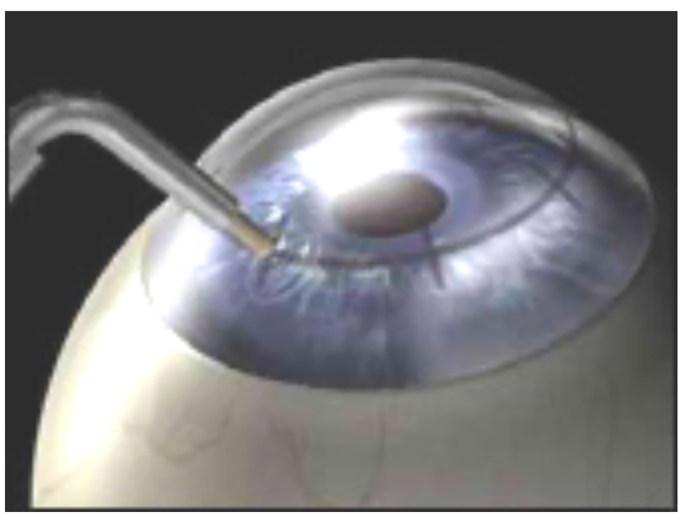
Visian ICL

The Visian ICL (Implantable Collamer® Lens) is placed in the eye with a procedure very similar to the intraocular lens (IOL) implantation performed during cataract surgery. The main difference is that, unlike cataract surgery, the ICL sits on top of the patient's OWN natural lens and does not require the removal of the eye's crystalline lens (please refer to the anatomy section for a better understanding of this procedure). Please note that the Verisyse lens sits on top of the iris, the ICL sits underneath the iris.

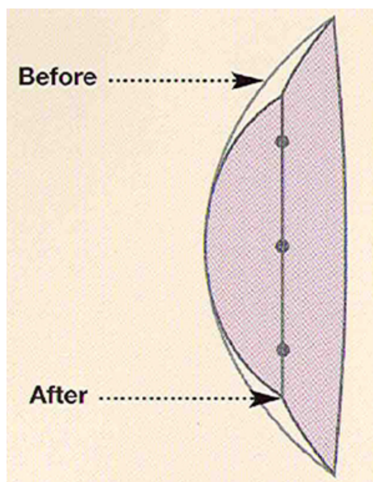


Conductive Keratoplasty (CK)

CK is a procedure approved by the FDA for the temporary reduction of hyperopia or presbyopia in patients over 40 years of age. CK uses radio frequency energy to reshape the cornea and make it more curved or more nearsighted.



It is safe and effective and takes only a few minutes. This technology, in my professional opinion, works well, but only for a year or so, after which the patient will require reading glasses again. As a result, I do NOT perform this procedure for my patients, rather I correct this problem with monovision correction with either LASIK or PRK. Alternatively, some patients choose to undergo clear-lens extraction with a multifocal lens (below).



Depending on the age of the patient, the latter option is a fantastic approach to correct patients' refractive errors and provide them with excellent near vision. The older the patient is (the more likely they are to develop a cataract in the near future), the more I am in favor of this procedure as they'll likely require cataract surgery sometime soon anyway.

Laser Thermal Keratoplasty (LTK)

LTK is a laser procedure that is referred to as no touch. This procedure corrects mild degrees of farsightedness. Heat is applied to the periphery of the cornea to shrink the peripheral collagen, indirectly steepening the cornea centrally. The procedure is non-invasive but has a tendency to regress. Its outcomes may also be less accurate than LASIK or PRK to treat the farsightedness. It is performed in select cases only and has to a large degree been replaced by CK.

Chapter 7

Former Refractive Surgery Procedures

Radial Keratotomy

RK was a popular procedure in the 70s. Established by Professor Fydorov in Moscow, it used to be the only procedure available to correct nearsightedness and astigmatism. With this procedure, multiple radial incisions were placed onto the anterior surface of the cornea to flatten it. Regression and over correction with issues of weakening of the cornea were noted. In the mid 90s, it was replaced by the more accurate laser vision correction.

Patients who still need to wear glasses after having had RK in the past, can still have their vision corrected with laser; I personally perform (and only recommend) PRK to treat such patients with which I have had patients with excellent outcomes.

Automated Lamellar Keratoplasty (ALK)

ALK is a surgical procedure developed in the mid-eighties to correct vision. The outer layer of the cornea is raised by a microkeratome creating a flap, followed by another pass over the cornea to reshape it. The LASIK concept was derived from ALK and has gained grounds for better precision and accuracy.

Novel approaches to help get rid of reading glasses (treat "presbyopia") using LASIK

As an eye surgeon specializing in laser vision corrective surgery, I am always surprised to see how little people know when it comes to their options regarding near vision correction. It is remarkable to see how people have five pairs of reading glasses laying around the house that they bought from the 99-Cent-Store, each covered with oily fingerprints, and each with a different prescription strategically situated near key areas of the house: one near the phone, one near the computer, one near their desk, and two in their purses or coat pockets. Not only is this a huge nuisance to those who suffer from what's called "presbyopia," but they feel it makes them look and feel "old," so it's also become a cosmetic issue.

As the middle-aged population in America becomes more used to the idea of cosmetic surgery, Botox, and the like, they also want to try to reverse this natural aging process so they don't have to rely on their reading glasses just to look their watch, cellular phone, or a menu at a restaurant. What almost everyone doesn't know is that there are multiple easy ways to get rid of reading glasses permanently.

So what is presbyopia? Presbyopia (literally means "old eyes") describes the progressive inability of our eyes to focus to see up close ("accommodate"). The way I often describe it to patients is: if you look at the natural lens inside a child's eye, it appears as a small, clear water balloon: it is very soft and pliable; but, if you look at the lens of a 80-year-old, it can be hard like a rock (called a Cataract). At some point between these two stages, the lens become so hard that it can't bend enough to allow us to focus, and this usually happens near the age of 40 years. Although it progresses slowly, once people begin to suffer from it, it really takes away from their quality of life, especially for those who read or work on the computer many hours a day. They complain they have to hold things further and further away to see them, their eyes fatigue easily, tear a lot, and more importantly, they hate having to keep putting the glasses on to read and take them off when they are finished.

So what can be done? There are many ways to get rid of reading glasses, but there are multiple factors that we have to take into consideration to decide which method is best suited for the individual: these factors include the age of the patient, the "natural" state of their eyesight (whether they're "near-sighted," "far-sighted" or neither), whether or not they have cataracts, and their occupational needs.

For those who have no cataract formation, we like to correct their vision so that they can see better for far with one eye (their "dominant eye"), and see better for near with the other ("non-dominant" eye); this is called "mono-vision."

Our brain naturally has a tendency to want to use one side of our body over the other. For example, we're either "right-handed" or "left-handed;" no one teaches us to prefer one side over the other, our brain naturally favors either the right hand or the left. The same applies to our ears, as well as our eyes: we naturally like to use one eye over the other to see images at distance. The best way to check this is to see which eye we see out of when we take pictures, look through a telescope, or to shoot a rifle: the one we keep open is our "dominant" eye.

So to this end, we correct the "dominant" eye to see far with (and keep the brain happy), and we adjust the prescription of the other eye to make it "near-sighted." By choosing the "correct" eye to fix, and by keeping the amount of near-vision correction below a certain limit (usually 1.75 Diopters), we are able to really help those who suffer from presbyopia.

There are multiple ways to do this (Conductive Keratoplasty (CK), LASIK, PRK (flapless LASIK)), but in my professional opinion, LASIK is the most precise, painless, easy, and accurate way to achieve this; the results are <u>instantaneous</u>, and the correction lasts a long time without changing (I should mention here that I myself have undergone LASIK, and the results have been absolutely remarkable).

In those who suffer from Cataracts (their natural lens has become opaque), the best approach is to remove their cataracts and place a crystalline lens in its place which has the ability to correct <u>both</u> near- and <u>distance</u> vision in <u>either</u> eye. This way, we don't even need to aim for "mono-vision" as <u>both</u> eyes can see near and distance perfectly at the same time. This approach is the most recommended option today by the American Society of Cataract & Refractive Surgery, and in my professional opinion, would also be the best option for those who, because of their age, are at an increased risk of developing cataracts any time (usually in their 70's).

With today's advanced diagnostic and surgical technology in the field of eye surgery, the risks of these procedures are very nominal, and these procedures are usually done in the office with only a few drops instilled as the only form of "anesthesia." None of these procedures take more than 10-15 minutes, and again, the results are almost instantaneous!

Chapter 8

LASIK — the Latest Advancements

LASIK is a two-step process that has been performed on millions of patients and it has proven to be safe and effective. In the last several years, however, two revolutionary advances have taken place in LASIK surgery. These two advances have added a new level of safety and precision to the procedure, compelling more patients than ever and even more eye doctors than ever to undergo LASIK vision correction.

The first advance is the improvement in the microkeratome, the hand-held mechanical device used to lift the superficial layer of the cornea called the flap. This step is necessary to expose the inner layers of the cornea where the reshaping laser, called the excimer laser, is applied to reshape the cornea, correcting nearsightedness, farsightedness, and astigmatism. Although the new microkeratomes have a much better level of cutting accuracy and safety profile, I still do not use them in my practice as there is an even safer technique available today that surpasses the keratome in many aspects.

As mentioned earlier, I only use the "all-laser" approach so there is no "cutting" the cornea with a blade. Rather, I use an intralase laser to provide me with a perfect flap every single time. This has really been shown to improve the safety profile of this operation, and is slowly replacing the keratome as the "gold" standard for LASIK surgery. You still see all the "discount" laser centers use the keratome routinely as the intralase laser is quite expensive and adds considerable cost to the procedure.

The second advance in LASIK eye surgery is the use of customized ablation profiles based on wavefront maps or data obtained by various measurements from the cornea. With these mapping systems, it is now possible to record the unique patterns in each person's vision system and transfer these maps to the excimer laser, and then use these maps to guide the laser in correcting each person's unique vision imperfections.

These new methods are highly accurate and sensitive maps to drive the treatments form the foundation of Custom LASIK.

Custom Reshaping

Just prior to applying the laser, the surface layer (the flap) is lifted to expose the inner corneal layers. The surgeon then uses the excimer laser to reshape the inner cornea. The excimer laser beam is guided by the Wavefront map of your vision. This map is typically performed on the day of your procedure, but could also be done at the preoperative exam or both. The map is electronically transferred to the excimer laser just prior to the procedure. It then guides the laser beam during the procedure to correct your vision, i.e., nearsightedness, farsightedness, and astigmatism, as well as smaller imperfections that often affect your night vision.

In reshaping your cornea, the excimer laser will vaporize tiny amounts of the corneal tissue at a rate of up to 200 beats per second. The exact pattern of how the cornea is reshaped will depend on the Wavefront map. In a nearsighted patient, the cornea will be flattened. In a farsighted patient, the cornea will be steepened. And in a patient with astigmatism, the cornea will be made rounder. As a result, the optics of the vision system will be improved so that the images can focus more perfectly on the retina.

Studies have shown that Wavefront-guided corneal reshaping often improves night vision, reduces the incidence of glare and halos at night, and improves contrast sensitivity.

The following diagrams illustrate how the flap is moved aside and computer assisted surgery is performed by a beam of laser light guided by the Wavefront map and controlled by the eye surgeon.

With Custom LASIK, we have refined the art of better vision for our patients. With the new generation of lasers, we can offer unprecedented safety and accuracy and give the world an astounding advance in medicine that until recent years was hardly imagined.

Aberrometer or Wavefront Analyzer

A device called an **Aberrometer or Wavefront Analyser** is used to measure how light is being bent and refracted through the cornea and onto the retina. It measures the entire optical system of the eye. This measurement is called a wavefront map. The goal with Custom LASIK is to optimize the quality of vision for each unique patient.

A 2nd device called a **Topolyzer** analyses the corneal surface and contours (topography) and we have the ability to use this information to drive a CUSTOM LASIK procedure too. Topography-guided treatments can also be done with information obtained from the Pentacam. When the Pentacam is used as a therapeutic tool, it is called the "Oculyser."

The 3rd way in which we can customize a treatment is with the use of the **Custom-Q** mode. This gives the surgeon more control over the final **asphericity** of the cornea ensuring better vision in all conditions, from bright sunlight to low light conditions at dawn & dusk or in really dark conditions such as country roads on a dark night.

The final way in which we can customize treatments is with the use of **MONOVISION**. This technique works well for patients who are already presbyopic (they need reading glasses or Bifocals / Varifocals) and wish to be entirely free of glasses after surgery. Here, the dominant eye is corrected for distance vision and the non-dominant eye is corrected for near vision and this is a very good compromise for a large proportion on patients (more discussion on monovision below).

During your consultation, the suitability of monovision should be explored, especially if you're near 40 years of age.

It is very reassuring to know that we have so many options to enhance your visual outcome, but it is important to realize we would still do around 70% of our procedures using the "standard" method. As you now know, nothing about this "standard" procedure is standard either as in its most basic mode, the laser still delivers a wavefront-optimized profile.

When one considers the various options available it becomes imperative that you are discussing your options with a qualified ophthalmologist who has specific refractive surgery experience and training.

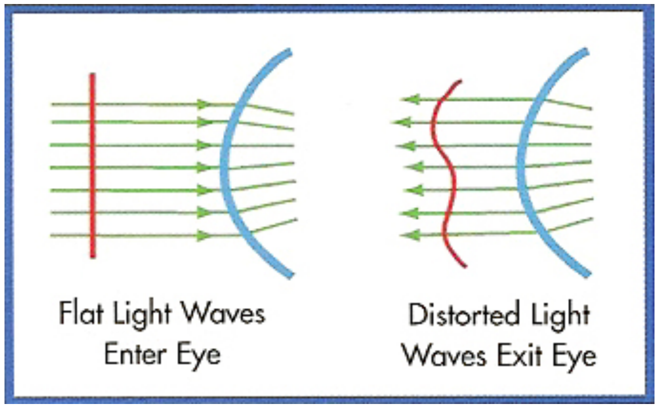
Wavefront & Topography

Wavefront mapping of your vision is an essential component of the Custom LASIK procedure. It will first direct the surgeon in deciding if you will benefit from the wavefront-guided laser vision correction. It then guides the laser in reshaping your vision according to the unique patterns in your vision map.

Wavefront technology was originally developed to be in high powered telescopes to reduce distortions when viewing distant objects in space. It was only a matter of time before scientists applied the precision of wavefront technology to reduce distortions in human vision. Prior to Wavefront technology, doctors could only measure the larger imperfections in a patient's vision — nearsightedness, farsightedness, and astigmatism. Therefore, we could help patients see as good as they did with glasses or contacts. Today, we can measure and correct the unique imperfections in vision and provide better vision than glasses or contacts.

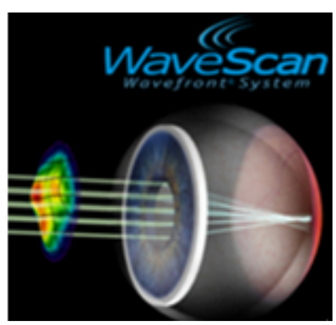
How Does Wavefront Mapping Work?

Prior to your Custom LASIK procedure, the Wavefront Mapping of your vision will be performed. You will be seated in front of a high tech device, called a Wavefront Aberrometer, and asked to look at the red target light in front of you.

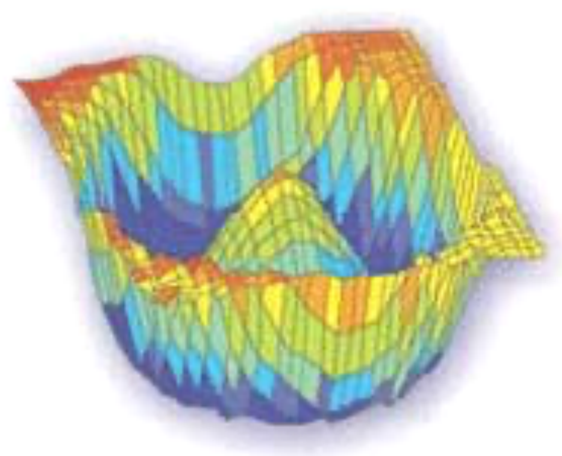


The wavefront

A laser image is projected through the cornea and the lens on to the retina. This beam of laser light will then be photographed on the retina. The photograph is then compared to the known image that was projected on to the retina. The differences in the 2 images are due to the wavefront errors or aberrations and these are used to generate a 3-D map that will be used for the surgery. This 3-D map is your Wavefront map.



The map will contain the unique pattern of irregularities in your eye's optical structures—large irregularities such as nearsightedness, farsightedness, and astigmatism, as well as small irregularities that can diminish the quality of your vision if they are present in significant amounts. These irregularities or imperfections are called aberrations. Large imperfections are called lower order aberrations and small imperfections are called higher order aberrations.



The scan shown here is the 3-D map of the reflected wavefront. This is a fingerprint of your vision, or a map. This information is then transferred to the excimer laser and is used as a guide to reshape the cornea during your Custom LASIK treatment

How Is Wavefront-guided Custom LASIK done?

First, we analyze your wavefront map and compare the results to all the other vision tests that were performed during your pre-procedural examination. An important test during your examination is your Refraction, i.e., when we place you in front of the phoropter and ask you which is better, "one" or "two"? This test measures how your brain interprets the prescription in your eyes' optics.

Refraction with the phoropter is an important step in the Custom LASIK process (replace with my picture)

In most patients, however, the wavefront map and refraction prescriptions are similar and wavefront-guided LASIK is an excellent option if you have problems with the quality of vision in low lighting conditions.

Once the mapping is completed, the aberrometer software creates a custom tailored treatment map and the information is delivered to the excimer system to reshape the cornea. Most excimer lasers have the ability for active tracking and iris registration to ensure centered treatment. The excimer laser is a cool ultraviolet laser that vaporizes tiny corneal particles to reshape the cornea.

The reshaping pattern will be based on the 3-D wavefront pattern to correct the imperfections in your vision that will include both your lower order aberrations and your higher order aberrations.

Keys to Successful Custom LASIK

The "5 T's to Successful Custom LASIK": Thoroughness, Technology, Technique, Tear Film, and Team. All five components must be in place with precision accuracy to achieve superb results.

Thoroughness

With any eye procedure, but particular in refractive surgery, thoroughness, and attention to detail is a very important key to successful results. Meticulous technique is essential to accurately acquire, match, and treat vision aberrations. All the data points have to be mapped. Excellent correlation between wavefront refraction and phoropter refraction needs to be achieved. Meticulous alignment between the wavefront map and the eye surface needs to be maintained during treatment.

Technology

The aberrometer needs to capture each patient's unique wavefront accurately. Patients have a wide range of prescriptions and therefore the aberrometer has to be able to detect a wide range of refractive errors that range from very high myopia to very high hyperopia, and significant astigmatism. It has to be able to detect the aberrations when the pupil dilates over 5mm. Higher order aberrations primarily come into play in dim light, when the pupil dilates. The aberrometer needs to detect and measure these peripheral aberrations in order for them to be treated.

Studies show that if the aberrations are not measured, they are not treated. The aberrometer also needs to detect many different types of higher order aberrations. While the spherical aberration (contributes to halo formation at nights) and coma (patients complain of seeing a "comma-shaped" tail around bright lights at night) are the most significant contributors to glare at night, many other types of higher order aberrations contribute as well. Therefore, the aberrometer needs to detect as many as possible so that they can be treated to maximize the quality of vision.

And lastly, the lens in the eye needs to be neutralized for accurate wavefront measurements. Under normal circumstances the lens of the eye tends to overreact and accommodate. To off-set such an induced reaction, your doctor may need to dilate the pupil to relax the lens in order to obtain precise measurements. Treating an accommodating eye may result in blurred vision due to overcorrection or under correction. Therefore, it is essential to acquire wavescan measurements when the patient is in a non-accommodative state.

The Wavefront map is performed with the patient sitting upright in front of the aberrometer. The corneal reshaping is performed with the patient lying down under the excimer laser. In many patients, the eyes rotate when they change body position from upright to lying down. This eye rotation is called cyclotorsion. The wavefront map, with its specific pattern of imperfections, has to match the eye surface for accurate treatment, much like Pringles potato chips have to fit perfectly together or otherwise crumble. Even a ten degree mismatch between the map of the eye and the position of the eye can lead to significant inaccuracies in treating vision imperfections. In fact, the imperfections may increase rather than decrease. Therefore, an accurate wavefront system has to have provisions to match the map of the eye in a sitting and supine position to avoid cyclotorsion. To this end, the laser I use the most (the Visx S4 has a (new) technology called iris registration. With this technology, the wavefront aberrometer actually takes a picture of the patient's iris in sitting position, and when prone, it aligns itself with the eye, the same way the machine "remembers" the picture was taken in sitting position. This provides for a perfect treatment match every single time.

The final critical component of the technology essential for accurate wavefront-guided treatment is the excimer laser itself. It has to have an ultra-fast tracker, a tiny beam that treats a wide area of aberrations. In a study published in *Journal of Refractive Surgery*, researchers found that to accurately follow and track the eye during treatment, the tracker has to sample the position of the eye at least 250 times per second. Less than that and the eye will not be tracked accurately. The laser is use most (the Visx S4), tracks the eye up to 4000 times a second!

It has also been found that as the beam diameter gets smaller, more imperfections can be treated, much like an artist can paint fine detail better with a fine tip brush. Ideal beam diameter is less than one mm.

The size of the treatment zone also matters. As the pupil dilates widely at night, a large treatment zone ensures that most of the light enters through the corrected cornea, reducing risk of glare at night. If the treatment zone is small, such as 6 mm, and the pupil dilates to 8 mm, some light will enter through the 2mm ring of uncorrected cornea and the patient will experience more glare at night.

Technique

Sterile technique is very essential for success of the surgery. Your eyes will be properly cleaned (prepped) prior to your operation. It is important to have very clean eyelids and eyelashes (no blepharitis) prior to any eye surgery as the bacteria residing on the eyelid margins have been found to be responsible for devastating eye infections. The regular use of post-operative antibiotic drops is extremely useful in preventing infections. With the advent of new 4^{th} generation "quinolone" antibiotic drops (Vigamox & Zymar), infections from refractive surgery have really become a thing of the past.

Formation of a good, healthy flap is paramount; at the end of the procedure, one should make sure that the flap is folded back, aligned and sealed to avoid slippage.

Tear Film

Tear film is part of the eye's optics. Therefore, stable tear film is required for the accurate wavefront map. It is recommended that patients remove their contact lenses prior to their Custom LASIK procedure for the duration of time prescribed by their eye doctor. Some patients may need to use lubricating drops two to four times a day while out of contacts. Some patients may require other interventions to stabilize their tear film prior to the procedure. In some patients, the tear film will never stabilize enough for accurate wavefront mapping and the best procedure for them will be refraction-based correction rather than wavefront-based correction. In any case, your tear film needs to be evaluated during the initial consultation so that appropriate recommendations can be made.

Team

High caliber technical personnel, in addition to the experienced surgeon, is required to integrate complex technology with these meticulous techniques. Extensive training, background in eye care, and even background in computer technology are often necessary.

Possible Risks with Custom LASIK

In order to make a decision as to whether Custom LASIK vision correction surgery is a good alternative for you, it is important to understand the potential risks. Today, if performed by an experienced LASIK specialist, with the right technology the risks of complication is extremely low— in fact, LASIK is now one of the safest surgeries performed today.

The most common "risk" of LASIK is that there may be a very tiny amount of "over-correction" or "under-correction" which may lead to slightly imperfect vision (e.g., 20/25 instead of 20/20). This is rare, but very easy to repair: your surgeon will lift your lasik flap, and treat the left-over prescription with the excimer laser. It shouldn't take more than 20 seconds altogether, and your vision will be 20/20 (or better) by the next morning after this procedure.

The other possible complication of LASIK is a problem with the flap itself. Considering the LASIK flap is only about 100μm in thickness and that it NEVER completely heals, this flap may become wrinkled or slightly torqued in one direction, in which case, the "striae" on the flap (depending on their location) may or may not interfere with perfect vision. Such flap related complications, if fixed early, should not cause any sort of permanent visual problems. This is why it is imperative that you are seen by your surgeon the next day following surgery, and any sort of flap irregularity and abnormality should be paid emergent attention.

With our improved surgical lasers, and with the advent of powerful ophthalmic antibiotics, and anti-inflammatory medications, infection, haze formation, and excessive inflammation are now extremely rare and should not deter anyone from undergoing LASIK/PRK.

The following are several factors that enter into whether or not the proper correction is achieved.

Unrealistic expectations

It is wise for those who undergo Custom LASIK to be fully informed and carefully assess their expectations. As a patient, your job is to understand exactly what the procedure can and cannot do. This is where communication with your doctor is essential. Your doctor should understand all of your expectations, and then explain what is realistic and what is not. Although this procedure is one of the most successful in all of medicine, even the most skilled and experienced surgeon cannot promise that you will have 20/20 vision correction.

With Custom LASIK a skilled surgeon can significantly reduce your dependence on glasses and contact lenses.

Dry Eye

Some patients experience a "grittiness" following Custom LASIK. This condition usually tends to resolve itself over the first one to three months. In the meantime, adequate application of the lubricating eye drops will often alleviate the symptoms.

It is important that your doctor evaluate you for dry eyes prior to the Custom LASIK procedure. If dryness exists prior to surgery, or if dry eye symptoms persist after surgery despite the frequent use of artificial tears, your doctor may recommend blocking your tear drainage canals with punctual plugs. This brief, painless procedure prevents your natural tears from draining away so quickly and results in improved lubrication of the surface of the eye. The use of Restasis eye drops has been proven to potentiate an increase in tear production.

Corneal Abrasion

Infrequently, one may develop a small corneal abrasion during Custom LASIK. Despite excellent surgical technique and an adequately moistened eye, a small breakdown in the epithelial surface may develop as the flap is made. Corneal abrasions are noted more so with the microkeratome rather than Intralase. This occurs in approximately 3% of Custom LASIK procedures because the surface cells do not adhere well. The medical term for this is epithelial basement membrane disorder. Unfortunately, doctors cannot always detect this preoperatively. A very thin bandage contact lens may be placed on the eye if this occurs to improve comfort and promote healing. The bandage contact lens is usually removed within the next few days. Fortunately, the epithelium grows back rapidly, usually healing within one to three days.

Night Glare and Halos

It is not uncommon for nearsighted patients who wear glasses or contacts to have symptoms of glare or see halos or starbursts at night. This is due to having longer eyes than normal sighted patients. Thus, at night in a nearsighted patient when the pupil dilates, peripheral light rays are scattered more before reaching the retina. It is this scattering that results in glare and halos.

With Custom LASIK, the chance of glare and halos is reduced significantly. Some patients with large dilating pupils and large corrections may not be optimal candidates for Custom LASIK, as their risk of glare and halos may be higher. Special laser programs that allow larger treatment zones can help reduce the chance of these problems. Your surgeon will optimize the size of the treatment zone based on how widely your pupils dilate at night.

Inflammation

A mild inflammation, called diffuse lamellar keratitis can sometimes occur under the flap. Although most patients have no symptoms, some may experience light sensitivity. The condition is typically treated with anti-inflammatory drops. Prevention requires maintaining meticulous surgical technique. After your procedure, you are routinely given the anti-inflammatory steroid drops to use for a week or so. These drops help prevent inflammation as well.

Corneal Flap Risks

With the advent of Intralase FS laser technology, the safety of the procedure increased significantly. In very rare instances the flap may show some straie (microscopic fold) which rarely interferes with vision. However, with time, this dissipates. Patients may worry about displacement of the flap. Nevertheless, this is extremely rare and is manageable.

Epithelial Ingrowth

Some of the corneal surface cells (epithelium) may get trapped beneath the flap, though this is rare. These cells typically do not create any problem, but occasionally they can cause mild blurriness or irritation. This problem can be easily identified and treated by gently lifting the flap and removing the trapped epithelial cells.

Undercorrection and Overcorrection

For a degree of nearsightedness or farsightedness, the amount of laser applied to a patient's cornea is based on the average person's response to the laser. However, individuals are different and may respond differently. Usually, this difference in response is not visually significant, but sometimes an undercorrection or overcorrection will occur.

Undercorrection is more common than overcorrection. A slight undercorrection will not seriously affect your vision and may be desirable following a nearsighted treatment in patients over forty to help with reading vision. Significant undercorrections may require an enhancement procedure (which is usually included in the original Custom LASIK fee).

Undercorrection and overcorrection are eliminated by surgeons using consistent technique and constantly analyzing their outcomes. Your doctor should keep an up to date database of procedures and be able to tell you what the likelihood is of needing retreatment.

The excimer laser comes from the factory with standard recommended settings. By fine tuning the factory treatment parameters, the surgeon minimizes the chance of undercorrection.

An initial overcorrection following a myopic treatment may occur and usually corrects itself within a few months. Following a hyperopic treatment, an overcorrection will make you temporarily nearsighted, making your distance vision somewhat blurry and your near vision rather good. These temporary undercorrections and overcorrections can be managed with glasses until they resolve. The number of overcorrections is fewer than that of undercorrections. The incidence of undercorrections and overcorrections in the best hands should not exceed 5%.

Enhancement procedures

Medically indicated enhancements are generally performed at least three months after the original treatment at no additional cost to the patient. The original flap created during the Custom LASIK procedure is lifted with a specially designed instrument. There is usually no need to cut a new flap; thus, the risks associated with creating the flap originally are not a factor in retreatment. Postoperative healing is normally faster than following the original procedure and the vision stabilizes quicker, because corrections are typically smaller. Your doctor can decide on the frequency of additional enhancements.

Decrease of Best Corrected Vision

A small number of patients may experience a slight decrease of visual sharpness following Custom LASIK vision correction. This means that even with glasses, you may lose some of the crispness and clarity of your vision. This can be due to irregular healing and usually improves over time. Careful surgical technique and good follow-up care help minimize the incidence of this problem. The incidence of this occurrence is less than 1% and it typically improves over time.

Infection

Although infection is the most feared complication, it is extremely rare. As with any surgery, it is avoided through sterile surgical technique and the use of prophylactic anti-biotic drops postoperatively. If it does occur, it manifests itself in the first twenty-four to seventy-two hours after treatment. That is why it is important for you to go to all of your follow-up visits, even if everything seems to be fine. However, in an exceedingly rare instance of an infection, it can be treated with antibiotic drops.

Regression

Regression refers to the tendency of the vision to drift back slightly toward its original prescription. This occurs more commonly in patients with higher amounts of myopia, hyperopia, or astigmatism. In myopic and hyperopic patients, there may an inclination for very negligible change in the prescription with age. This change may marginally impact the quality of vision. An enhancement can be performed to help with these changes.

If regression makes your vision blurry, an enhancement procedure may be performed to "tune up" the original treatment. Enhancements for regression are usually performed anywhere from one year to five years following the original procedure to allow time for the patient's new refraction to stabilize. In some cases, glasses for night driving may be all that is needed.

How to Analyze Published Data and FDA Studies

An essential concern of patients, besides having an expert surgeon with the skill needed to accurately perform Custom LASIK, is the technology track record.

Different technology platforms are often compared in terms of percent of patients who see 20/40 or 20/20 or better after the procedure. For example, you may read that with laser X 95% of patients saw 20/20 or better six months after the procedure while with laser Y 79% of patients saw 20/20 or better. Does this mean that laser X is better than laser Y? Not at all! In order to compare the two lasers, you have to make sure that you are comparing apples to apples, not apples to oranges.

First, you have to make sure that the lasers were used to treat patients with similar amounts of refractive error. Clearly, patients with -2 D myopia are more likely to achieve 20/20 after procedure than patients with -10 D myopia. If patients treated with laser X had lower prescriptions than patients treated with laser Y, then they would be more likely to achieve 20/20. Compare mean preoperative refractive error, standard deviation, and the range of refraction treated.

Additionally, compare the number of patients at the follow-up time point when the results are compared. If only half the original patient sample treated with laser X showed up for a follow-up exam six months after the procedure compared to laser Y, then the data may be artificially skewed in the laser X sample.

Also, analyze the reason why more patients achieved 20/20 with laser X. It could simply be that there was no refractive error left postoperatively with laser X, whereas a little bit of nearsightedness, for example -0.50D was left over with laser Y. This means that the surgeon using laser Y can simply add extra 0.50 D to each treatment and the results will be the same as with laser X. This is called a simple "nomogram adjustment" and can be easily incorporated into the programmed treatment plan, making the results of laser X and laser Y the same.

In fact, if you take into account the statistical differences and nomogram adjustments and then compare the 20/20 outcomes of all the wavefront laser platforms currently approved by the FDA, you will realize that the results are, in fact, similar. They seem better in some platforms, mainly because fewer patients came in for follow-up exams.

The real test of the wavefront-guided Custom LASIK treatment is how well higher order aberrations are recorded. Diagnosing the higher order aberrations and improving the quality of vision is the real purpose of wavefront-guided Custom LASIK. In fact, with these wavefront laser systems, the chance of you having fewer imperfections in your vision than you had with glasses or contact lenses is five times better with the wavefront-guided Custom LASIK than with the conventional procedure. Make sure to ask your surgeon if he or she uses the system that has been shown to reduce higher order aberrations in clinical trials.

The currently FDA approved "wavefront guided" lasers are:

- Visx (by AMO, which recently purchased intralase)
- Ladar Vision (by Alcon, which recently purchase the wavelight "allegretto")
- Bausch and Lomb

Although the surgeon cannot promise 20/20 vision without correction, historically ninety-five percent of typical myopic patients achieve vision within two or three lines of 20/20 vision without correction. In fact, the vast majority of patients can drive without glasses the day after their Custom LASIK surgery. With Custom LASIK, great day <u>and</u> night vision is now within your reach.

We have been performing the wavefront-guided LASIK several years Furthermore in the past few years, we have found that Topography-guided procedures, using either Topolyser or Oculyser data, are giving even better results than wavefront-guided treatments in these patients with visual quality problems. This finding shouldn't really surprise anyone – we know from the anatomy chapter that the cornea is the most powerful lens system in the eye and that small imperfections in the cornea have a large impact on the visual quality. Obtaining corneal information may therefore be of more value than wavefront information when correcting these aberrated eyes.

Chapter 9

Selecting the Right LASIK Surgeon

The keys to successful, safe surgery in any field of medicine are an informed patient with realistic expectations and a skilled, experienced surgeon. Take the time to research the surgeon and the laser team that you are considering for correcting your vision. *Ask questions!* The following guidelines will help you in your quest.

Begin with People You Know

A word-of-mouth network often provides a good initial source of information. Ask your eye doctor. Your eye doctor is critical in your decision making process. First of all, he or she is familiar with your prescription and your vision needs. Also, the doctor is able to evaluate the surgeon's work first hand with at least several patients and compare the work by different surgeons. Your eye doctor should have your best interests in mind. He or she will only recommend what's best for you. Also, ask family, friends, and associates if they could recommend a surgeon based on personal experience.

It is imperative that you have the conviction that your LASIK surgeon will treat you with your best interest at heart. A high quality eye surgeon who has successfully treated other eye doctors, friends and family is usually a good bet.

Consult Physician Directories

Physician search directories available on the Internet may be helpful. Keep in mind, however, that these directories are not exhaustive listings of all the refractive surgeons in your area, only those who have chosen to participate in them. Some directories are new and have a limited number of listings; other directories charge a fee for listing the surgeon's name.

You should also remember that the majority of these sites and their referrals do not check a surgeon's credentials. So make sure you thoroughly research a surgeon's credentials before making the final decision.

As a general rule of thumb, do not trust "discount" LASIK centers, and do not trust any "doctor" who treats treats his/her work as a business and has an "assembly-line" practice. Although these LASIK practices do a high volume of patients, the "rush factor" is a huge deal, and you shouldn't let anyone be rushing you in and out of the room when it comes to a surgery that will affect your life for a lifetime.

Contact Boards and Medical Associations Ophthalmic

Ophthalmic boards and medical associations offer useful information about board certification, licensing, and other pertinent criteria. Among the better known entities are the American Academy of Ophthalmology, the American Society of Cataract and Refractive Surgery, and the International Society of Refractive Surgery.

You should contact your local or national ophthalmic associations for their lists of member surgeons. Be sure to contact more than one professional organization, as not all ophthalmologists are members of each one. Even if you have heard of good surgeons from a friend, relative, or acquaintance, take the time to check their professional credentials.

What to Look for

Board Certification

Always look for a board certified physician. This is the medical profession's generally accepted form of accreditation. This information can be obtained from the American Academy of Ophthalmology or the American Medical Association (AMA).

Fellowship training

The surgeon must be fellowship trained specifically in **refractive surgery**. This is a source of confusion for a lot of people. There are lots of people who have done a "cornea" fellowship, where they did only 5 LASIK cases the ENTIRE year they spent as a "fellow!" This does NOT, by any means, qualify anyone as a "refractive" surgeon, so as a consumer, you have to see not only where they trained but with whom, what technology did they have at their disposal, how many did they do, and how often are they doing LASIK now. Where I trained, we had every single excimer laser at our disposal (an Autonomous, a Visx, and an Alegretto, plus we had the intralase laser, and my mentors were both intacs surgeons, so I had the opportunity to be certified with all of these technologies under proper supervision.) MOST centers do NOT have this technology available on site.

I know many general ophthalmologists who do one or two cases a month at an "open-access" center and call themselves "experts;" this, in my opinion, is not enough experience or practice to qualify anyone as a "refractive surgeon." Needless to say, I manage a LOT of other people's complications, and I really feel this procedure should be better regulated as to prevent people without adequate training from doing it; not only is it dangerous for the patients, but this is where the rumors come from that LASIK is dangerous: you have to see who did the case with sub-optimal results.

Surgeon's Age

For the most part, the younger generation of refractive surgeons have a much better grasp of the available technologies and techniques, and they "grew up" using them rather than have to learn how to do LASIK at an "academy meeting." Although knowledge and experience comes with developing some "gray hairs," I highly advise you not to be too trusting of those who claim to do LASIK, but are used to doing cataract surgery with 40-year old techniques. Use a surgeon who is knowledgeable of the newest techniques and technology in refractive surgery, not necessarily just a great doctor who did your grandmother's cataract surgery; refractive surgery is a very different specialty.

Experience with the Procedure

You would like a surgeon who has been doing refractive surgery exclusively for at least two-three years. Experience in dealing with different patients' refractive needs and surgical results over time are most valuable and cannot be overstated. The more experience a surgeon has the better. Refractive surgery is both an art and a science, including assessing different patients' needs before surgery, performing the surgery with great attention to detail, following the healing process, and intervening (if necessary) postoperatively. Refractive techniques and technology change over time. This experience imparts to the surgeon a comprehensive understanding of the surgical process and enables him or her to satisfy each patient's needs.

Numerous studies have shown that surgeons experience a learning curve with the LASIK procedure. It has been shown that surgeons who have performed over 1000 procedures have a lower complication rate than those who have performed fewer. Generally, it could take approximately 200 LASIK procedures before your surgeon is able to develop a fine adjustment of this final treatment plan. Having said that, I have personally witnessed ophthalmologists who have performed over 20,000 LASIK procedure and I would NOT trust anyone's eyes in their hands!!! This is where "word of mouth" and "inside" information is very helpful. You should NOT be "fooled" by the appearance of their offices or the extent of their advertising, you should see what technology they're using and how long they've been using it.

I heard an ad on the radio when I was a fellow stating that a certain doctor has a "20-year track record" of doing "all-laser-lasik" whereas LASIK had only being around for 10 years or so, and the intralase technology had only been out for 2 years! After calling them, I learned that he's been doing "LASIK" for only 5 years, and he purchased his intralase laser 6 months prior to the ad!" He has being doing Radial Keratotomy (RK) for 15 years, NOT LASIK! This sort of false advertisement is dangerous and you should think twice before you fall for it. Another example is a center which I know advertises "all-laser LASIK," and they charge for intralase technology but use a regular keratome when the patients are on the table; the patients' just don't know the difference (they're currently being sued!).

You need to be aware, however, that even in the best hands, enhancement procedures are necessary about 2-5% of the time. Different people can have a small variance in response to the laser, in particular those with higher prescriptions are more likely to need an enhancement.

In the process of performing these procedures, the surgeon should make every effort to meet or exceed benchmark standards in order to achieve good outcomes. By constantly analyzing surgical outcomes, the better surgeons find that the consistency of their results improves, even beyond the initial 1,000 procedures.

Find out how much experience the surgeon has with your procedure. Ask if they have a nomogram. Ask to see it. Ask how frequently they update it.

Do not be deceived by a laser center that has done several thousand procedures. It is the surgeon that makes a difference.

Tracking Results

As a potential patient, you should ask your doctor how he or she tracks LASIK procedure outcomes. The doctor's response can tell you a great deal. If the surgeon has done extensive work developing excimer laser technology, presents his or her data at well respected conferences to other surgeons, or publishes, you can be confident that he or she is tracking their results.

Because there is no mandatory central reporting database for tracking results, the important thing is to determine if the surgeon is tracking and not worry too much about any one specific number. The fact that the surgeon is tracking LASIK outcomes shows his or her concern for achieving the best possible results. Your goal is to find someone for whom achieving excellence is a paramount concern.

Success and Complication Rates

Next, ask the surgeons how long they have been performing refractive surgery and Custom LASIK and about their success and complication rates. Your doctor should discuss the potential success rate for your individual surgery, as well as any potential complications. Surgical success means more than knowing how to avoid complications; it means knowing how to handle difficult situations before they arise. Identifying problems early and dealing with them in a timely manner is the hallmark of excellent surgeons. All surgeons have complications, but that does not mean that anything was done wrong. What is important is that the surgeon has a low complication rate and that the ultimate visual outcomes are good.

It is also important to know about their experience with refractive errors similar to your own. The surgeons should have adequate experience with people of the same age, gender, and race as you because the surgical techniques needed to correct refractive errors in these groups may differ slightly from the norm.

Enhancement Policy

An enhancement surgery is any follow-up laser treatment after the first surgery to further improve a patient's vision. How liberal or stringent is the surgeon's policy on enhancement surgery? Some of the offices may not allow enhancement procedures to further improve uncorrected vision (vision measured without contact lenses or glasses) unless a patient sees 20/50 or worse.

For instance, after the first procedure your uncorrected vision is 20/40 and your desire for an enhancement to further improve your vision may not be allowed. Even though most people can pass their drivers test with 20/40 vision, some patients may not be happy with this level of vision for their distance acuity.

Prior to making a decision to have refractive surgery, it is important to understand the center's policy for allowing you to have enhancement surgery. Do they allow enhancements only if your uncorrected vision is 20/50 or worse? Also, what if your vision is 20/40, 20/30, or 20/25 after the first surgery and you want it improved? Will they allow an enhancement under your global fee since they corrected you to 20/40 or better?

Will you be charged for an enhancement? What exactly is their policy? Always feel free to ask.

Beware of "Lifetime Guarantee"

With "Lifetime Guarantee", you may be promised enhancements free of charge "for life." Often, many exclusions apply. For example, enhancements for farsightedness (hyperopia) may be excluded. You may need to have yearly exams after your procedure to qualify for free enhancements. And while you should have your eye health checked yearly, sometimes you may be traveling or living outside the US and not be able to come back in a year for a check up. What if you come in a year and a half later? Will "Lifetime Guarantee" still apply? What if you have glare at night and need a wavefront-guided enhancement, or custom upgrade? "Lifetime Guarantee" often excludes these and you may have to pay an additional fee for this type of enhancement.

Excimer Laser Capability

The computer software that operates the excimer laser varies from manufacturer to manufacturer. And while all excimer lasers have the software necessary to perform simple treatments, not all have the advanced wavefront capabilities. In selecting a surgeon and a laser center, make certain that the doctor's laser has the capability of correcting your vision using your wavefront map. You may hear "wavefront optimized" or "custom". These terms don't necessarily mean that the laser platform is capable of wavefront-guided treatments. Ask the doctor specifically about wavefront-guided treatment.

Awareness of New Developments

Most doctors keep up with the latest developments by reading or attending conferences. Some doctors take this a step further and immerse themselves in a life style of innovation by lecturing at major conferences, teaching surgical technique to other doctors, participating in clinical trials for new technology, and consulting for ophthalmology companies.

Ask the doctors you talk to if they know what is being achieved, both nationally and internationally, in their field. Or contact one of the major ophthalmologic societies directly with the same question.

Personal Compatibility

Remember, personal chemistry is extremely important. Choose a doctor with whom you feel comfortable; someone who is easy to talk to, friendly, and professional; someone who listens closely to what you want and cares about what you need. Make sure he or she is willing to take the time necessary for your understanding of the procedure. A good doctor-patient relationship is important in helping devise a treatment plan that best suits your needs.

The art of medicine entails blending the science of medicine with the needs and expectations of the individual patient. Many excellent LASIK surgeons and LASIK centers offer consultations that give you an opportunity to assess the quality and excellence levels of the person to whom you are entrusting your eyes.

Competent, Compassionate Staff

Verify that the laser center is staffed with highly trained, competent professionals. Determine for yourself whether the LASIK surgeon has the competent team to insure an excellent outcome for you. Here are some questions that may help you find the right team:

- Does the surgeon work with other eye care professionals to assist in patient examinations?
- Does the surgeon have technical support for lasers and the advanced technology?
- Have any of them had refractive surgery with the surgeon?
- Does your prospective surgeon have his own laser on-site, or does he share with a group of other surgeons at another location?
- Does s/he have a laser brought into his office or other center on surgery days?
- Does it appear overall that the surgeon has made a significant commitment to excimer laser and LASIK surgery?
- Does the surgeon have a doctor(s) working with him that specializes or spends most of their time working with preoperative and postoperative LASIK patients?
- Do they understand your needs?
- What is their experience and role in the delivery of your care?
- Have they had LASIK surgery? I personally see this question being very helpful to my own patients. Having

had LASIK myself, I feel I can really explain the entire experience to my patients better and really provide a better understanding of what they should expect, before, during, and after their procedure.

- Who will be doing the surgery?

Care Provider and Style of Care

Determine who will be performing your pre-operative and post-operative care. Many patients choose to see their family optometrist or ophthalmologist for their preoperative and/or post-operative care. Such an arrangement is known as co-management. Some feel that this can enhance the overall level of your care, but personally, I would want the operating surgeon to follow me after my surgery, NOT an optometrist or even a general ophthalmologist, especially one who has no idea what they're looking at.

Find a Qualified Surgeon

Find an experienced LASIK surgeon who will make the commitment to you to take full responsibility to give you the best possible result from LASIK and who will be actively involved in every aspect of your LASIK procedure.

Be sure you know who is actually doing the procedure; I have seen people go to a center because they've heard great things about the surgeons, pay good money to have them do their surgery, but have another doctor cut their flap, even do the entire case!

Ask who will be doing your follow-up. Ask about their qualifications. Find out how many procedures he or she has done, and remember, higher volume does not necessarily imply a better surgeon. Ask what his or her success rate is for 20/20 vision or better. What is his or her rate of loss of best corrected vision?

Remember, when evaluating the criteria you feel that a LASIK surgeon should meet, take time to listen to your feelings. This is one sure way to feel comfortable with the surgeon you finally select. At any point in the decision making process, should you have doubts about the surgeon or his or her medical assessment, go elsewhere and obtain a second opinion.

Ask How Many LASIK Procedures the Surgeon Has Performed

It is important to be specific with regard to LASIK since many surgeons have performed other laser procedures that require different skills than those required for LASIK. Just because the surgeon has done thousands of cataracts or glaucoma procedures does not mean that he or she has done many LASIK procedures. I have seen people tell their patients they've done thousands of "refractive" procedures, but in reality they've done 20 LASIK cases altogether (the rest were cataract surgeries). Ask your surgeon how many cases they've done similar to what you're considering.

Does the Surgeon Maintain a Database of a number of LASIK Procedures?

This database will allow the surgeon to provide you with statistics regarding his or her results. Specifically, the surgeon will be able to provide you with a reasonable prediction of what your result will be (based on your preoperative refraction) and the likelihood of needing an enhancement procedure to fine tune your result.

Choose the Right Surgeon and Pay What It Costs

Discount surgery is as good as a discount parachute. Many advertisements push low cost surgery. This is an important warning signal to proceed with caution. Go for the best qualified surgeon and the treatment team.

Beware of the Hard Sell

Be wary of promises or guarantees seen in advertisements, such as "20/20 vision or your money back" or "lifetime guarantee." Of necessity, such statements contain fine print and initiate the doctor-patient relationship in a rather deceptive manner. Go elsewhere. You are not buying a car. This is real surgery. Your surgeon should be well aware of the limits of LASIK and readily acknowledge the probability of complications in high risk patients. Also, beware of the ads that sell you LASIK for $499 an eye; most such ads are referring to very low prescriptions (e.g., -0.50D), which usually don't even need to be treated! Chances are, your refraction is higher than a -0.50D, in which case, you'll have to pay a LOT more per eye, plus, if you have astigmatism, you pay more, plus, if you want intralase technology, you pay more, plus, if you want "custom" LASIK, you pay even more; by the time you leave the center, you're paying upwards of $5000!!! Such ads are designed just to get you to come in, and they'll "sell" you the surgery when you're there. Personally, I have an ethical problem with such business tactics when it comes to a medical procedure; it makes the practice more like a used car lot, not a doctor's office.

Internet Research: Proceed with Caution

Many leading LASIK surgeons have taken the extra effort to establish web sites that can detail their practice, qualifications, and success rates. This information is useful in your research. However, the web is also filled with inaccurate information. A small group of patients may voice concerns over complications. Keep in mind, that these may be the patients who had the procedure performed with older technology, before the Intralase and before wavefront-guided LASIK. Many of their concerns can be resolved with simple post-operative treatments, such as specific drops for your dry eyes, or wavefront-guided enhancement to improve night time vision. If you have a good rapport with your surgeon, you should be able to bring up your concerns to him or her directly and let them help you.

While you investigate, don't lose sight of the benefits: for most people, a lifetime of bad vision can be cured in fifteen minutes.

Custom LASIK has improved the eyesight of over a million people around the world. Your LASIK surgeon need not be your best friend, but you should have every confidence that he or she possesses the skill and experience necessary to apply the technique of Custom LASIK in a way that best serves your interests.

Chapter 10

Initial Consultation

The first step in your Custom LASIK Procedure is the consultation which is important for several reasons. First, it must be determined whether you are a good candidate. Second, it is also vital for you to learn as much as you can about your options and have as many of your questions answered as possible.

The style of the initial consultation may vary between different surgeons. Some surgeons may not require you to be out of contact lenses prior to coming in. They will perform autorefraction to measure your prescription, topography to examine the shape of your cornea, and pachymetry to check the corneal thickness. Based on the results of these tests, they will determine if they can perform Custom LASIK for you. If not, they will recommend the best procedure. After you have been out of contacts for the recommended period of time, you will come in for your pre-procedural exam where a more thorough eye examination will be performed to get you ready for the procedure. With some laser systems, your pre-procedural exam can be done on the same day as your procedure. At this visit, a detailed eye examination is performed. Depending on the results of this examination, you may be asked to stay out of contact lenses longer and then come in again for another examination prior to your procedure.

Some patients may prefer to come in for a brief consultation first to simply find out if they can have Custom LASIK and not bother staying out of contacts if they can't have the procedure. If they can have the procedure, they can simply remove the contacts for the specific time prescribed to them rather than a generic length of time which may not even be necessary. Additionally, the shorter consultation is typically free, while there is usually a charge for the longer exam. If for some reason you are not a candidate, you may not want to incur the expense of a full examination.

The first step to Custom LASIK is to find out if you are an excellent candidate.

What to Expect During the Consultation

Required Tests

1) Meet the Doctor
   a) Share your interests
   b) Understand your specific needs
   c) Comprehend the technology and the procedure
2) History: It is important to disclose your full medical history when assessing whether Custom LASIK is the right procedure for you.
   a) Occupation – tailor the procedure to your individual needs
   b) Contact lens wear – contact type and extent of wear (daily wear, extended wear, gas permeable). Patients that use soft contacts should refrain from wear for about a week and those that use gas permeable contacts should refrain from wear for at least 4 weeks

c) Reading glasses
d) Stability of refraction
e) History of glare or halos, especially at nights
f) History of previous eye surgeries
g) History of medical diseases, i.e., herpes simplex eye infection, rheumatoid arthritis, lupus, autoimmune disease and drug intake
h) Use of a pacemaker
i) History of migraine headaches
j) History of dry eyes
k) Familiarity with monovision for presbyopic patients

Autorefraction

Automated equipment that measures your prescription by projecting light to the back of your eye and measuring its shape when it comes out. Typically, this test is about 95% accurate in measuring your prescription enough to determine what procedure is best for you. I ROUTINELY double-check the machine's refraction with the wavescan's readings, and I also perform a manual "manifest" AND a "cycloplegic" refraction (see below) to make 100% sure all four are equal; this prevents any treatment mistakes, and your doctor should do the same!

Autorefraction is often the first step in your Custom LASIK process (REPLACE WITH PHOTO OF ME DOING AN AUTOREFRACTION

Topography

Corneal mapping to determine the smoothness and symmetry of your cornea. The importance of topography is primarily to identify patients with a bulging cornea, i.e., keretoconus – a contraindication for surgery. There are different types of topography systems, however, the standard of this care at this time is utilizing a system called the orbscan or the pentacam.

Corneal topography (elevation map) is performed to evaluate the corneal surface (replace with my photo0

Pachymetry

Ultrasound measurement of your corneal thickness. Average corneal thickness is between 500 and 600 microns. The thickness, however, may vary by as much as 30 microns from exam to exam. If your corneal thickness is marginal, it should be rechecked once you are out of contact lenses for 2 weeks. Some surgeons refrain from performing Custom LASIK in cases less than 500 microns to avoid weakening the cornea, i.e., ectasia. Today, we know that it's the "residual corneal thickness" (thickness of the remaining cornea (under the flap) that remains after the procedure has been done) that matters most, not the pre-operative corneal thickness.

Tonometry

Your eye pressure will be measured by a digital device to rule out glaucoma. It is very important that you surgeon checks your eyes for glaucoma (and any other eye disease)

Wavefront Mapping

You will be seated in front of the wavefront aberrometer and asked to look at the red light. The ophthalmic technician will perform the mapping. The mapping step is very important to the successful outcome of your procedure and should not be delegated to just anyone. A highly trained team member with extensive background in eye care is ideal for this step.

Manifest Refraction

Your prescription will be measured with technology called the phoropter. Different lenses will be dialed in and you will be asked to choose which is better, "one" of "two" or "both." Your vision will be tested in different ways to make sure that the measurements are consistent.

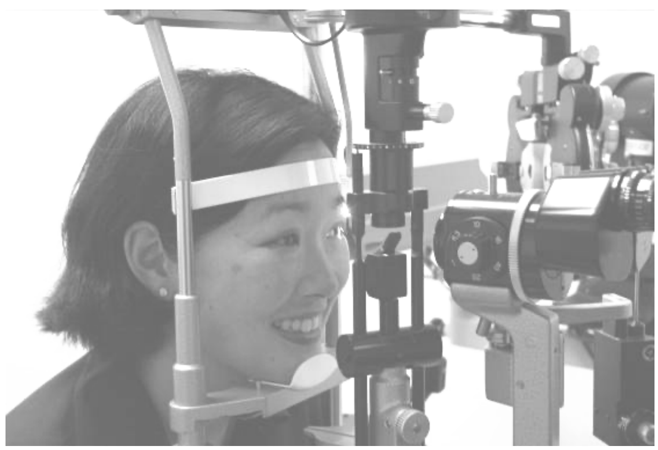
Pupil Size

Pupil size will be measured with infrared pupillometer to determine its size in the dark. One should make sure that the laser treatment zone is larger than the pupil size in the dark state to avoid halos and glare at night.

Slit lamp examination

Utilizing the magnifying equipment, the surgeon will examine your eyelids, conjunctiva, tear film, corneal health, and ensure that you do not have a cataract. Following ruling out any lid infections, conjunctivitis and corneal degeneration, a thorough assessment of the eye for dryness is completed, i.e., shirmer tear test, tear meniscus, tear breakup time and rose bengal test.

Dry eyes need to be treated aggressively prior to the procedure, preferably by placing tear drops frequently, utililization of Restasis drops that potentiate tear productivity or placement of tear duct plug.



Slit lamp examination is performed to evaluate the tear film and the health of your eyes???

[Let us know why the question marks on caption.]

Eye Dilation and Cycloplegic Refraction

An eye drop will be used to dilate your pupils and to temporarily immobilize your lens so that it can relax and stop accommodating. Pupil dilation allows the doctor to examine the back of your eye – your retina and optic nerve. Generally, the eye dilation should last about 4 hours. Occasionally, especially in younger patients, a strong dilating drop may be used. The effect of this drop may last into the following day.

Discussion

Once all the information is gathered, you will have a discussion with your surgeon. The surgeon will review your medical and vision history. It is important for your doctor to know everything about your medical history as certain systemic diseases such as rheumatoid arthritis, lupus, and other autoimmune diseases are a contraindication. Certain healing disorders, diabetes, a cardiac pacemaker, and a current or planned pregnancy may need special consideration. The ocular history will include questions about previous contact lens wear and eye disease. The doctor will want to know if you have dry eye and/or if you've had a history of recurrent erosions or basement membrane disease.

Another eye disease that the doctor must be aware of is *herpes simplex* on the eyes as well as potential kerotoconus. The doctor will explain to you that diseases such as glaucoma or diabetes will not preclude you from having the procedure, but they must be identified and controlled. It is important for you to notify the doctor during the consultation of any ongoing changes or problems with your vision. If you have a significant cataract, you should not undergo LASIK vision correction.

Please be prepared to let the surgeon know your medications and allergies.

To be a candidate for Custom LASIK, you must meet the following requirements:

- Be over eighteen years of age
- Myopia up to –15.00 diopters or hyperopia up to +6.00 diopters, with or without astigmatism (up to 5.00 diopters).
- Stable vision for at least a year.
- Be free from certain diseases of the cornea, lens, and retina.
- Not pregnant or nursing
- No evidence of early cataract formation (people with cataracts should just have their vision corrected by having their lens removed, not by lasik.

The following are NOT CONTRAINDICATIONS to laser vision correction, but need to be discussed with your surgeon:

- History of glaucoma, uveitis, certain corneal irregularities
- Previous eye surgery including radial keratotomy (RK), PRK, lens surgery, cataract surgery, corneal transplant
- Diabetes
- Advanced age

Informed Consent

Prior to your surgery date you will have the opportunity to read and understand the informed consent. Any remaining questions that you may have about the healing process and what to expect during and after the procedure should be addressed prior to surgery.

Patients over age 40 that are interested in preserving their reading vision may experience monovision, where one eye is corrected for distance and the other for reading. Such a combination should be demonstrated with a temporary contact lens fitting to simulate the outcome.

Tour of the facility

Of all the concerns that people face considering refractive surgery, fear of the unknown is perhaps the greatest. By touring the facility, seeing where you will have your procedure, you can be assured that you are in good hands and all will be taken care of for you.

Chapter 11

The Day of Your Custom LASIK Procedure

On the day of your procedure, you should arrive at the laser center as rested and relaxed as possible: mental readiness plays a great role in how nervous you are during the surgery, and you should be ready and excited to finally getting the procedure that will help get rid of your glasses for ever!

You should probably allow about a two hour stay at the laser center. This may vary from center to center. You will need to arrange transportation for the day of the procedure. Wear comfortable clothing. Do not wear makeup on the day of your laser surgery. These things may interfere with the cleanliness of the procedure and the function of the excimer laser. Likewise, do not wear your hair in a bun. Your head needs to lie flat during the procedure, and the bun will cause your head to be unstable and uncomfortable.

Contact lenses must be removed from the operated eye as recommended by your surgeon. However, as a rule of thumb, soft contact lenses need to be out for at least 1 week, gas permeable hard lenses 4 weeks, and toric contact lenses 3 weeks. It is essential that your eye be in its most natural state at the time of surgery. You will be given a consent form to read and sign. The majority of surgeons will meet you at that time to review the date, set the plan and demarcate your astigmatism to offset any cycloversion movement during surgery.

Prepping for Custom LASIK

With Custom LASIK, a mild oral sedative may be administered before the procedure begins; I personally prefer you do not take any Xanax or Valium, but I have it available for very nervous patients upon request; I myself did not need any such medication during my own LASIK. During the procedure, your surgeon and the team will be talking to you. They will talk you through the entire procedure; you will know at all times what to expect.

Because Custom LASIK is surgical in nature, sterile surgical conditions must be maintained. You will be given an antibiotic drop, a non-steroidal anti-inflammatory drop, and an anesthetic drop to improve comfort. You will also be given a surgical cap to wear. While the drops begin to work, the area around your eyes will be cleaned with a betadine disinfectant.

The Procedure

Step 1: Creating the Corneal Flap Using Intralase

You will be positioned properly under the laser microscope and the fellow eye will be covered. Additional anesthetic drops will be placed in the operative eye and a small speculum will be placed in your eye to keep your eyes from blinking; this is entirely painless.

During the process of creating the corneal flap, you will feel pressure sensation and the lights go dark; this is the same whether or not your surgeon is using a microkeratome or the Intralase in making a flap. There's no reason to panic because you can't see anything at this step; this is completely normal and will last about 30-60 seconds (depending on the speed of the laser and the agility of your surgeon).

Step 2: Custom Corneal Reshaping

The superficial layer will be unfolded using a think metal hook that your surgeon uses to lift your flap and your vision will get blurry again. With the intralase, you will feel your surgeon is "wrestling" with your eye: s/he will ask you to look toward the light as s/he is pushing your eye down toward your feet. It really helps if you're able to resist the movement, thereby giving him/her some "counter-traction." This helps him/her easily lift up your flap, and this is exactly why I don't like my patients too sleepy with medications, because I find they have a hard time following orders when they're so "drunk."

You will be asked to fix your vision on a red flashing light, which may appear slightly orange or yellow in color. The laser part of the procedure is then performed, and is regulated by the pre-programmed mapping. Advanced laser systems are also equipped with a high speed computerized eye tracker that helps to enhance the treatment by providing the precise registration of the laser beam to create the customized ablation surface.

This corneal reshaping step could take anywhere from several seconds to several minutes, depending on the speed of the laser platform being utilized, the amount of your correction and the amount of higher order aberrations. This portion of the procedure is painless, but you may notice a faint "ozone" odor (smells like new electronic equipment just out of the box) as the laser photoablation proceeds. You will also hear a clicking sound with each pulse of the laser. It is very important that you just focus on the bright flashing light above you; that's your ONLY homework.

Your eyes are continually making very fine "saccadic" (jumping) movements. These movements are simply unavoidable since, try as you may, you will be unable to control them. As your eye moves, it will appear as though the fixation light is moving. Keep following the red fixation target light and you will be fine. The tracking system in the advanced lasers assists the surgery by scanning the eye thousands of times per second and by making computer micro-adjustments many times per second to reposition the pinpoint laser beam between pulses of light. This technology tracks the very smallest and quickest movements of your eye throughout this phase of the treatment.

The excimer laser is designed to use an ultra-small beam of cool laser light — one that is less than a millimeter wide, a good deal smaller than the thickness of a single hair. Using high speed computer control, the excimer laser moves this tiny beam of rapid light across the surface of the cornea in a tiny, non-sequential and overlapping pattern. The result is a smooth customized corneal shape that gives a fast visual recovery and individualized correction.

At the completion of the ablation, the superficial corneal layer is placed back into its original position and your vision will clear somewhat. There is a slight waiting period for the eye to create a natural vacuum to hold the flap down. The cornea has the unique ability to seal itself naturally back into place resulting in a complete and smooth replacement. This simply indicates how marvelous the human eye is at adaptation.

After the drying is completed, the lid retractor is removed and you are able to blink normally. In some patients after having LASIK, and in all patients having PRK, your surgeon will place a clear non-prescription contact lens on the eyes to aid in their individual healing process.

After your Custom LASIK surgery is completed, you will be asked to remain a while in the surgicenter for observation and postoperative instructions. At this point, congratulations are in order: you are all done, and can throw away your old glasses and contact lenses for ever.

Chapter 12

Postoperative Care after Custom LASIK

Once your procedure is completed, antibiotic drops will be instilled and clear plastic shields will be placed over your eyes to protect them. You will then be instructed to go home and take a nap. You will be asked to keep your eyes closed, typically for four hours, to allow adequate initial healing. Because your vision will be blurry and you have received a sedative, you will need to have someone drive you.

Typically, you will be instructed to wear the clear plastic shields over your eyes for one to three nights. These prevent accidental trauma to the corneal surface during the healing period should you inadvertently bump your eye.

Before you go home to rest, your surgeon may also give you something to help you sleep, for this is the best way to keep your eyes closed for the first few hours. Following LASIK surgery, you may experience some burning or discomfort, which may last a couple of hours. Patients describe the discomfort as a "sandy feeling" or liken it to having a dirty contact lens in their eye.

With LASIK, this discomfort typically subsides with sleep and is usually gone by the next day. Tylenol®, ibuprofen, or similar over the counter pain medications are usually adequate to keep you comfortable.

You will also be given antibiotic eye drops, anti-inflammatory eye drops, a mild steroid, and lubricant eye drops to promote healing. It is common for the eyes to feel somewhat dry, and the lubricant drops (also called "artificial tears") may be used frequently.

Immediately after the surgery, you can expect your vision to be fairly blurry. It may look as though you are looking through a glass of water or fog. With Custom LASIK there is usually a dramatic improvement in vision in the first twenty four hours.

With PRK, your vision will usually immediately return to 20/20-20/40 range, but your quality of vision will not be great until your eipithelium is entirely healed (usually takes 5-10 days). Until then, you will most likely feel irritation, light-sensitivity, and depending on the person, pain. This will all resolve over time with no adverse sequelae. Your doctor may even give you some topical "numbing drops" to take home with you after PRK. Although this really helps control the pain, these drops significantly slow down the healing process and should be used as sparingly as possible.

Guidelines for Healing

Follow these guidelines to promote safe and rapid healing:

- Rest and sleep aid recovery.
- Particularly in dry climates, apply non-preserved lubricant eye drops very frequently. This encourages rapid recovery and enhances comfort. (Some patients may

need these drops every hour the first few days, every couple of hours the first week, and at least four times daily for the first three months.)

- Sensitivity to light is normal and will improve. Wear good ultraviolet-protecting sunglasses.
- Avoid rubbing your eyes and squeezing your eye lids, especially during the first twenty four hours after surgery. You can rub your eyes gently two weeks after surgery.
- Avoid swimming and hot tubs for one week.
- Showers and baths are fine, but try to avoid getting water and shampoo directly into your eyes for at least two weeks.
- Cardiovascular exercise is fine the next day. You can resume heavy weight lifting in a week. Avoid getting sweat in your eyes during the first week.
- Avoid dusty or smoky environments immediately after surgery.
- Avoid eye makeup for one week.
- It is a good idea to plan on not driving until you feel your vision has improved. You may drive as soon as you are visually comfortable. This may be the next day or may take a few days.

Postoperative Follow-up Schedule

When you leave the laser center, you will be given complete instructions to follow, including a postoperative appointment schedule. Here is a typical postoperative appointment schedule:

Time	Purpose of Appointment
1 day	To ensure that there is no evidence of infection, that the surface is healing properly, and to remove the bandage contact lens (if one was used)
1 wk., 1 mo.	To ensure that your eye is healing properly
3–6 months	To measure your visual progress and to consider enhancement treatment (if necessary)
12 months	To measure the stability of your result, check your eye pressure, and assess your general eye health

The Custom LASIK Recovery Cycle

Your vision improves quickly after Custom LASIK, and many patients feel comfortable enough to drive in one to two days. The superficial corneal layer is relatively adhered in one week, but it is advisable not to rub your eyes vigorously for one week.

For the first three to seven days after your surgery, you will be using medicated eye drops. It is generally advisable to continue using lubricant drops for the better part of the first month after your procedure. Well lubricated eyes heal better, maintain better visual stability, and are more comfortable. These drops are available over the counter. Your doctor can advise you on which drops are best for you.

The return of visual stability after Custom LASIK varies for each patient. For some, stability can be achieved in as few as one to two weeks; for others, stability may take up to six months. As a rule, vision will improve in three hours, more in three days, three weeks, and even in three months. Generally, during the course of the first month, there is gradual improvement in good vision following Custom LASIK. You can also expect a reduction in nighttime halos and some return of near vision in patients over forty.

It is important that you keep your postoperative appointments as your drop regimen may be altered. Also, the doctor needs to monitor your eye pressure if you are on postoperative steroids for two weeks or longer. Be sure to keep your follow-up appointments.

Most patients enjoy good functional vision during the first month. Fluctuations in your vision are common during the first two to three weeks, especially for higher visual corrections.

Patients undergoing hyperopic Custom LASIK (farsightedness treatment), especially in the higher ranges (+3.00 to +6.00 diopters), will notice that their visual recovery is typically slower compared to patients having myopic LASIK (nearsightedness treatment). After farsightedness treatment, patients often notice that their near vision is better than their distance vision. This is quite common, and is actually what we want! Their distance vision will continue to improve during the first month.

Some patients may feel more comfortable with a thin pair of glasses to assist them with more critical distance vision activities, such as night driving or attending a play and trying to see the expressions on the actors' faces. Patients over forty years of age may require a thin pair of reading glasses.

While many patients notice halos around lights or ghosting of images at night, these symptoms tend to diminish substantially over the first month.

Patients with a history of dry eyes, or who use the computer, read for long hours, drive long distances, or live in low-humidity climates may notice some minor discomfort and blurring of their vision, particularly toward the end of the day. This is usually related to dryness of the surface of the eye. The frequent use of lubricant drops and a conscious effort by the patient to blink more during these activities will help significantly.

With Custom LASIK, your vision usually becomes stable within three to six months. Once your vision is stable, your treatment is permanent. You now have less dependence on, and maybe complete freedom from glasses and contact lenses.

Chapter 13

Patient Results with Custom LASIK

The decision to undergo Custom LASIK refractive surgery is based on either vocation, convenience, or safety reasons, which makes it an elective procedure rather than a medical necessity. The decision to have the surgery is completely up to you, unless the surgeon determines that you, for medical or other reasons, need to have the procedure. For example, if you keep getting corneal infections or abrasions with contact lenses, Custom LASIK may be a safer option for you.

There are many ways to present patient outcomes after refractive surgery, and the difference in numbers can be confusing. Some doctors may talk about the percentage of patients who achieve 20/20 vision after the first treatment, while others may present data on the number of patients who achieve 20/40 vision. Still others may discuss their results based on patients who have had enhancement procedures (if necessary). What are the important numbers and how can you interpret these outcomes?

First of all, to drive legally without glasses you need to have 20/40 vision. This is an important number; however, it is also important to know your chance of achieving 20/20 or better vision without glasses. Additionally, it is important to know the likelihood that you will need an enhancement (retreatment) procedure. These numbers depend on your initial prescription and are also surgeon dependent. Patients with higher degrees of nearsightedness, farsightedness, or astigmatism have a higher likelihood of needing an enhancement procedure. Surgeons who are reluctant to do an enhancement or have minimum visual acuity cut off requirements for enhancement will have a lower enhancement rate. Surgeons who are comfortable doing small touch ups, are more likely to fine tune patients' vision with enhancement.

Keep in mind that even the patients who do not achieve 20/20 vision without glasses are usually happy. They can do most things, including drive a car, without any correction. And when it is absolutely necessary for them to see 20/20, they can use a thin pair of glasses to do so before they are ready for a "touch-up" (usually done after 1-3 months after the primary procedure).

With Custom LASIK, an experienced surgeon can give you great vision. In the FDA studies, over 90% of patients achieved 20/20 or better vision without glasses or contact lenses.

In the U.S. Navy studies, patients saw better with Custom LASIK compared to conventional laser treatments. Not only did they have better visual acuity, but also, better contrast sensitivity and better ability to see well in dim light.

Nighttime vision is significantly better with Custom LASIK. The chance of glare and halos is reduced. In fact, the chance of you having fewer imperfections in your vision than you had with glasses or contact lenses is five times better with the wavefront-guided Custom LASIK than with the conventional procedure.

Medical studies and scientific data may provide compelling evidence in support of having Custom LASIK vision correction performed. Nevertheless, the most convincing testimonies come from the many patients who provide firsthand accounts of their procedures that resulted in much improved vision and a better quality of life.

For the benefit of potential patients who are considering LASIK surgery, comments from several individuals are given in the following pages.

"I'm an instructor at the Equinox Gym in Newport Beach, CA, and I have hated wearing glasses all my life. Because of my 7 Diopters (yes, seven Diopters!) of Astigmatism, I have had to wear RGP contact lenses for years, and every optometrist (and ophthalmologist) I had seen before told me there's "no way" I could have refractive surgery until I came to see you. I now see 20/20 out of each eye without the need for any glasses or contact lenses, and I can go on with my life and teach my Aerobics class without the inconvenience of my contacts. Thank you so much for doing such an amazing job with my eyes Dr. S., I can't thank you enough."
-Kim K.

"Dear Dr. Soroudi, I wanted to thank you so much for helping me regain vision in my eye after I had my eye operated on 10 years ago after being hit with a metal stick. I have since been told there's "nothing to do to fix this problem" until I saw you. I now see 20/20 out of an eye that has been so blurry for so many years. Thank you so much for your help."
-Armando R.

"Thank you so much for helping me see 20/10 out of each eye after having to use contacts throughout my medical school and residency years. I can't begin to tell you how many nights I have endured with dry irritated eyes because of contact lenses being on-call at the Hospital. It's amazing to know I can see this clear by PRK. I wish I had this surgery years ago, and I recommend it to anyone."
-Dr. Moses A., M.D. (Internist)

Dear Dr. Soroudi, I had RK 15 years ago by a reputable eye surgeon. For the past 7 years, I've had to wear glasses to see better and even with my glasses I had lots of visual problems. I now see 20/20 out of each eye, and I've never been happier with my vision. So many doctors told me there's nothing to do except contact lenses until I came to see you. Thank you so much for such an amazing job, and for all your great attention to detail.
Dr. Danial N., MD, Anesthesiologist

Dear Dr. Soroudi, I can not tell you how happy I am with my monovision. Because of my farsightedness, I have had to wear glasses with bifocal segments so I can see far and near. I now see 20/20 at distance and I can read even the smallest print without glasses or contacts. Thank you so much for such an amazing job.
Dr. Sam N., PhD., Executive, the Edison Corporation

Chapter 14

Summary

Custom LASIK is the procedure of choice for virtually all but the most extreme myopic and hyperopic patients, and even in those rare cases, there are now so many new safe and extremely effective options available today, with many more on the horizon.

There is NO patient who needs to wear glasses or contacts today who can't benefit in one way or another from refractive surgery, and I really urge you to disregard information stemming from those who are not refractive surgeons about your surgical options (I urge you to read the introduction of this book again very carefully before you decide to postpone your decision to have something done today).

It is also very important to understand the natural limitations of the eye (such as presbyopia) and any specific conditions that you may have.

I really hope you found the information in this book useful to make a well-informed, educated decision about what procedure would be most helpful to you and who would be the person to do it for you.

Conclusion

Custom LASIK is the most important advance in the sub-specialty of refractive surgery. Custom LASIK has improved the outcomes and stability of refractive surgery. It has gained widespread acceptance in the field of ophthalmology and optometry, and with the general public in the past two years.

What does the future hold? Currently in the United States, myopia, hyperopia, and astigmatism have all been approved for treatment.

Refractive surgery is becoming more and more commonplace. Some speculate that children will get their braces at twelve, their driver's license at sixteen, and their refractive surgery at eighteen (or sooner).

Chapter 15

Questions and Answers

Q. Am I too old to have Custom LASIK?
A. There is no upper age limit to Custom LASIK. Patients in their 90's have had Custom LASIK eye surgery. Your doctor will examine both eyes thoroughly. If your eyes are healthy, you should definitely consider this procedure to help you see better without glasses or contact lenses.

Q. Am I too young to have Custom LASIK?
A. The lower age limit recommended by the FDA is 18 years old. Your vision has to be stable (i.e. your prescription within 0.5 diopters) for at least a year and your eyes must be healthy. Younger patients often undergo Custom LASIK to help them in sports, to avoid wearing contact lenses during extended studying times, and prior to serving military duty or starting police or firefighter work.

Q. Can I fly after LASIK?
A. Certainly. The cabin air is pressurized, so it is similar to being on the ground. However, the environment is very dry, so you will need to use lubricating drops every hour. Some patients may be concerned traveling the second day following the

procedure. Nonetheless, you can even fly the day after your Custom LASIK procedure.

Q. Can I scuba dive after Custom LASIK?

A. Certainly. You should wait at least three weeks before getting into the water. After that, you can scuba dive. A recent scientific study published in the Journal of Cataract and Refractive Surgery evaluated the safety of scuba diving as deep as 100 ft on Navy SEALS who had LASIK. Scuba diving after LASIK had no effect on the eyes at all and was found to be safe.

Q. Can I mountain climb after Custom LASIK?

A. You certainly can! There should be no effect on vision at any elevation.

Q. Will my night vision get worse after Custom LASIK?

A. Many studies have shown that night vision remains excellent after Custom LASIK. In many patients, it's even better than their night vision with their glasses or contact lenses. As the eyes heal, especially during the first month after the procedure, some patients may experience glare at night. This goes away with time. If it doesn't, an enhancement may help. Custom LASIK, with advanced wavefront technology, improves the quality of vision both day and night.

Q. My eyes already feel dry with contact lenses. Does it preclude me from having LASIK? Will my eyes feel dryer after LASIK?

A. Contact lenses may prevent normal tear film circulation and many people actually experience the sensation of dryness while wearing contact lenses. This doesn't necessarily mean that your eyes are actually dry. Typically, your doctor will ask you to stay out of contact lenses for at least a week before the preoperative exam to let your tear film stabilize. Your eyes will then be tested specifically for dryness. Even if you do have some dryness, it doesn't necessarily preclude you from having Custom LASIK. Your doctor may give you drops or place plugs in your tear ducts to help your eyes accumulate more tears. Also, studies have shown that with Intralase, the incidence of dryness is reduced significantly, compared to the mechanical microkeratome.

Q. If I have Custom LASIK now, will I need to get it done again in the future?

A. Custom LASIK is a permanent correction. Your prescription should not "go back" or "reverse." Between three and six months after the procedure, your doctor will check your vision. If you have a little bit of nearsightedness, farsightedness, or astigmatism causing blurry vision, you may have an enhancement to eliminate it if medically safe. Only about 5% of patients need an enhancement. Your vision should stay stable after the enhancement.

Q. If a patient had conventional LASIK in the past, can that person qualify for Custom Wavefront LASIK?

A. Patients who have already undergone a LASIK procedure can be evaluated with the wavefront scan system. An enhancement procedure can be performed with Custom Wavefront technology if higher-order aberrations are present.

Q. Will LASIK accelerate my need for reading glasses?

A. The need for reading glasses, also called presbyopia, develops as the lens inside the eye gets harder and can't accommodate anymore to focus on near objects. This typically happens in our 40's. With Custom LASIK, the surgeon will correct the shape of your cornea to improve your distance vision. The lens changes will happen regardless of whether you have LASIK or not. LASIK will not speed up presbyopia. Most people will still need to wear reading glasses in their 40's.

Q. What is Presbyopia?

A. It is a vision condition caused by loss of flexibility of the crystalline lens that makes it difficult for one to focus on close objects, i.e., reading. It affects most people in their mid-forties. It is easily recognized when a patient holds reading material at arms length. To correct presbyopia your doctor may prescribe reading glasses, bifocals or contact lenses.

Q. Can Custom LASIK correct presbyopia?

A. Custom LASIK cannot correct presbyopia. However, there have been some modifications of the laser treatment to provide presbyopic patients with Monovision as a solution.

Q. How does Monovision work?

A. Your doctor will correct your dominant eye for distance vision and your non-dominant eye for reading. Eye dominance is analogous to right or left handedness. Your doctor typically will identify the dominant eye. Because monovision can affect your optimum depth perception, it is recommended that your doctor place a contact lens in your eye to simulate your post operative vision. If one has any hesitation whatsoever, surgery should be put on hold until comfort level is attained with monovision contact lenses.

Q. Should I have Custom LASIK done now or should I wait for new technologies?

A. An experienced surgeon using current state-of-the-art technology can give his or her patients outstanding vision without contacts or glasses, both day and night. If your eyes are healthy and your prescription is within the range of the currently available technology, you should experience excellent vision after the procedure. It would be a pity to deny yourself that excellent vision while you are waiting for "the next best thing." However, if your prescription is outside the range of currently available technology or is at the upper most limit of it, it would be reasonable to wait until the technology allows your surgeon to offer an excellent outcome.

Glossary

Ablate - in surgery, is to remove.

Ablation zone - the area of tissue that is removed during laser surgery.

Accommodation - the ability of the eye to change its focus from distant objects to near objects.

Acuity - clearness, or sharpness of vision.

Astigmatism - a distortion of the image on the retina caused by irregularities in the cornea or lens.

Cornea - the clear, front part of the eye. The cornea is the first part of the eye that bends (or refracts) the light and provides most of the focusing power.

Diopter - the measurement of refractive error. A negative diopter value signifies an eye with myopia and positive diopter value signifies an eye with hyperopia.

Dry Eye Syndrome - a common condition that occurs when the eyes do not produce enough tears to keep the eye moist and comfortable. Common symptoms of dry eye include pain, stinging, burning, scratchiness, and intermittent blurring of vision.

Endothelium - the inner layer of cells on the inside surface of the cornea.

Epithelium - the outermost layer of cells of the cornea and the eye's first defense against infection.

Excimer laser - an ultraviolet laser used in refractive surgery to remove corneal tissue.

Farsightedness - the common term for hyperopia.

FDA - the abbreviation for the Food and Drug Administration. It is the United States governmental agency responsible for the evaluation and approval of medical devices.

Flap & Zap - a slang term for LASIK.

Ghost Image - a fainter second image of the object you are viewing.

Glare - scatter from bright light that decreases vision.

Halos are rings around lights due to optical imperfections in or in front of the eye.

Haze - corneal clouding that causes the sensation of looking through smoke or fog.

Higher order aberrations refractive errors, other than nearsightedness, farsightedness, and astigmatism, that cannot be corrected with glasses or contacts.

Hyperopia - the inability to see near objects as clearly as distant objects, and the need for accommodation to see distant objects clearly.

Inflammation - the body's reaction to trauma, infection, or a foreign substance, often associated with pain, heat, redness, swelling, and/or loss of function.

Informed Consent Form a document disclosing the risks, benefits, and alternatives to a procedure.

In Situ a Latin term meaning "in place" or not removed.

Iris - the colored ring of tissue suspended behind the cornea and immediately in front of the lens.

Keratectomy - the surgical removal of corneal tissue.

Keratotomy - a surgical incision (cut) of the cornea.

Keratitis - inflammation of the cornea.

Kerato - prefix indicating relationship to the cornea.

Keratoconus a disorder characterized by an irregular corneal surface (cone-shaped) resulting in blurred and distorted images.

Keratomileusis - carving of the cornea to reshape it.

Laser - the acronym for *light amplification by stimulated emission of radiation*. A laser is an instrument that produces a powerful beam of light that can vaporize tissue.

refers to creating a flap in the cornea with a microkeratome and using a laser to reshape the underlying cornea.

Lens - a part of the eye that provides some focusing power. The lens is able to change shape allowing the eye to focus at different distances.

Microkeratome - a surgical device that is affixed to the eye by use of a vacuum ring. When secured, a very sharp blade cuts a layer of the cornea at a predetermined depth.

Monovision - the purposeful adjustment of one eye for near vision and the other eye fordistance vision.

Myopia - the inability to see distant objects as clearly as near objects.

Nearsightedness - the common term for myopia.

Ophthalmologist - a medical doctor specializing in the diagnosis and medical or surgical treatment of visual disorders and eye disease.

Optician - an expert in the art and science of making and fitting glasses and may also dispense contact lenses.

Optometrist - a primary eye care provider who diagnoses, manages, and treats disorders of the visual system and eye diseases.

Overcorrection - a complication of refractive surgery where the achieved amount of correction is more than desired.

PRK - the acronym for photorefractive keratectomy which is a procedure involving the removal of the surface layer of the cornea (epithelium) by gentle scraping and use of a computer-controlled excimer laser to reshape the stroma.

Presbyopia - the inability to maintain a clear image (focus) as objects are moved closer. Presbyopia is due to reduced elasticity of the lens with increasing age.

Pupil - a hole in the center of the iris that changes size in response to changes in lighting. It gets larger in dim lighting conditions and gets smaller in brighter lighting conditions.

Radial Keratotomy - commonly referred to as **RK**; a surgical procedure designed to correct myopia (nearsightedness) by flattening the cornea using radial cuts.

Refraction - a test to determine the refractive power of the eye; also, the bending of light as it passes from one medium into another.

Refractive Errors - imperfections in the focusing power of the eye, for example, hyperopia, myopia, and astigmatism.

Refractive Power - the ability of an object, such as the eye, to bend light as light passes through it.

Retina - a layer of fine sensory tissue that lines the inside wall of the eye. The retina acts like the film in a camera to capture images, transforms the images into electrical signals, and sends the signals to the brain.

Sclera - the tough, white, outer layer (coat) of the eyeball that, along with the cornea, protects the eyeball.

Snellen Visual Acuity Chart - one of many charts used to measure vision.

Stroma - the middle, thickest layer of tissue in the cornea.

Undercorrection - a complication of refractive surgery where the achieved amount of correction is less than desired.

Visual Acuity - the clearness of vision; the ability to distinguish details and shapes.

Vitreous Humor - the transparent, colorless mass of gel that lies behind the lens and in front of the retina and fills the center of the eyeball.

Wavefront - a measure of the total refractive errors of the eye, including nearsightedness, farsightedness, astigmatism, and other refractive errors that cannot be corrected with glasses
Courtesy of US FDA

About the Author

Dr. Soroudi specializes in the medical and microsurgical management of complicated eye disease and is an expert in the field of keratorefractive surgery. He has been recognized as one of the most skilled and meticulous eye surgeons in the country and has had extensive training and experience to treat ocular conditions that often lead to complete blindness.

He received his undergraduate training in Biomedical Engineering and graduated with the highest honors (magna cum laude) from USC. He obtained his Master of Science Degree in Physiological Science from UCLA in only one year and went on to the UC Irvine College of Medicine to obtain his Medical Doctorate Degree. He obtained extensive surgical training at the LA County Hospital in East Los Angeles as an intern, and completed his residency and served as chief resident in Ophthalmology at the LA County Hospital in South Central Los Angeles under the supervision of internationally recognized eye surgeons from the UCLA Jules Stein Eye Institute

Dr. Soroudi spent a year at the Division of Ophthalmic Plastic & Reconstructive Surgery at UCLA where he had the opportunity to learn more about complicated eyelid surgery. He also completed a clinical fellowship in kerato-refractive surgery at the Cedar-Sinai Medical Center where he obtained subspecialty training in performing all-laser and "flapless" LASIK., which he performs routinely at his practice in Newport Beach. He is among a rare group of eye surgeons who offer Intacs, which provide a revolutionary new treatment for Keratoconus.

He has also invented and patented a product approved by the FDA to treat a great number of conditions that commonly affect the eyelids (e.g., Sties).

He is on staff at the UCLA Jules Stein Eye Institute as Clinical Instructor of Ophthalmology, and is a Diplomate of the American Board of Ophthalmology.

Dr. Soroudi is the Surgical Director of the Soroudi Advanced Eye Center at 7305 Pacific Boulevard, 3rd Floor, Huntington Park, CA 90255, and he also operates in Newport Beach at 2121 E. Coast Highway, #200, Corona Del Mar, CA 92625. He could best be reached at (323) 587-7000 or on the web at www.lalasikcenter.com.