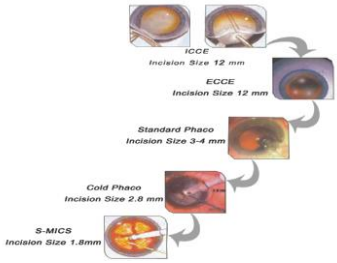
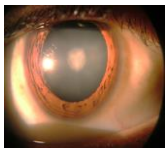
Cataracts: What Happened Before IOLs ?



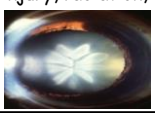
Dianna Graves, BS Ed, COMT has no financial relationships to disclose. She is an Independent Continuing Education Consultant.

PSC



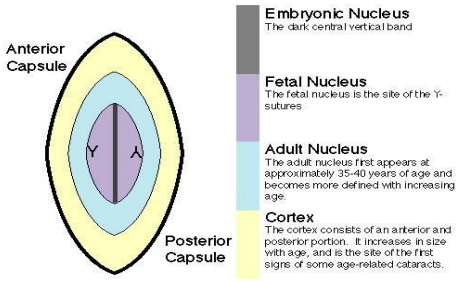
The word cataract was first coined by the Greeks and means "waterfall". It was thought that a cataract was formed by opaque material *flowing* into the eye. Actually, the *clouding* of the normally transparent lens is caused by any of the following (or a combination of) : aging, metabolic changes, injury, radiation, toxic chemicals or drugs.

Cortical



Rosette

Anatomy Of The Lens



opt.indiana.edu

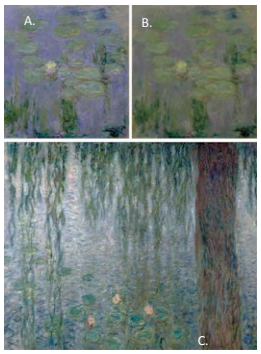
doctor-hill.com

kplaservisioncorrection.com

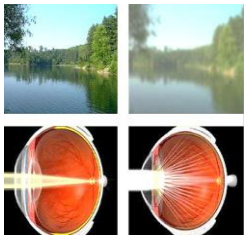
bremseyecenter.com

eyespecialistsofla.com

Image A was painted when Monet had a moderate cataract (1915). Image B gives a perspective of how Monet would have seen the picture. Image C shows the improved detail and contrast that Monet was capable of seeing, and creating, once the cataract was removed in 1926.



uniteforsight.org

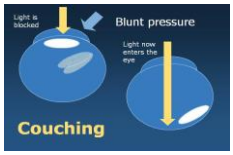


Cataract surgery is the removal of the lens that has become opacified. Many patient's first symptoms involve glare from lights, along with reduced acuity in low light situations. During cataract surgery, the cloudy lens is removed and replaced with a synthetic lens to restore the lens's transparency

norwicheyes.com

Couching

Cataract "surgery" in its *simplest* form is at least 4000 years old. **Couching** of the cataract was the earliest method used all the way back to 2000 BC. and is mentioned in the Bible and the Red Sea Scrolls as well as early Hindu writings.



telemedicine.orbis.org

castrovinci.blogspot.com

Couching could only be performed after the lens became completely opaque, rigid, and so heavy that the zonules became fragile. The eye would then be struck with a blunt object with sufficient enough force to dislocate and break the zonules. The lens would dislocate and fall into the vitreous. This restored limited, but completely unfocused, vision. Centuries later, the couching technique was modified. Instead of using a blunt object, a sharp instrument was inserted into the eye to break the zonules and dislocate the lens.

mrcophth.com

castrovinci.blogspot.com

Code of Hammurabi

The **Code of Hammurabi** was decreed in 1750 BC . Hammurabi, was the sixth king of Babylon .
This code included a payment plan for the surgeon if sight was restored, along with a penalty in the form of removal of the surgeon's fingers should the patient die or lose their eye. This is where the phrase "An Eye For An Eye" was first coined!

The code is also one of the earliest examples of the idea of presumption of innocence, and suggests that the accused and accuser have the opportunity to provide evidence.

Jacques Daviel

Daviel, a French ophthalmologist, is credited with originating the first *significant* advance in cataract surgery since couching. He performed the first *extracapsular* cataract extraction on April 8, 1747 .
This procedure used an inferior incision by needle knife, (triangular keratomes with cutting leading edges) and curved scissors, to access and remove the lens nucleus. The use of an inferior approach was a natural choice for a patient that was seated and *held by helpers*. Bell's phenomenon would naturally turn the eyes up and the gush of aqueous irrigated both the lens cortex and bacteria outwards from the eye.
This new procedure caused heated debates over the merits of couching versus extracapsular extraction well into the next century. (ascrs.org)

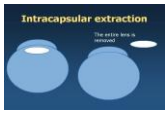
Elbrecht von Graefe

Von Graefe (1828-1870), was a German Ophthalmologist that developed a small, linear superior limbal incision for extracapsular surgery rather than the large incision. The benefits were better surgical outcomes in the form of lower post op infection rates, less post operative astigmatism and a faster recovery time. Von Graefe designed a narrow bladed knife that was exceptionally sharp and long. He also introduced iridectomy, to avoid pupil block caused by post op synechiae.

ambercity.com

ICCE
Intracapsular Cataract Extraction

Karl Koller ,an Austrian ophthalmologist, became aware of cocaine and its potential as a local anesthetic during eye surgery in 1884. He had tried other anesthetics (such as morphine) but it did not work as well.



Prior to his discovery, eye surgery was extremely difficult to perform due to the reflex squeezing of the eyelids with even the slightest stimulation near the eye.

grendahl.com

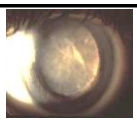
ICCE was developed in the 1980's, and was designed to remove the entire lens as well as the capsule. This procedure has a high rate of post retinal detachment, expulsive hemorrhage during surgery and complications associated with the large incision (≥ 10 mm).

telemedicine.orbis

To perform, the surgeon makes a large superior limbal incision (10mm or larger –"9:00 to 3:00") and injects medication into the eye designed to cause the zonules to dissolve. A special probe is then placed on the lens, and liquid nitrogen is applied to freeze the lens. As the probe is gently withdrawn from the eye, the lens (cataract) is removed.

visualedge.org.

Cryo-extraction was developed by Dr. Charles Kelman in 1962 as a form of ICCE that freezes the lens with a cryogenic substance such as liquid nitrogen. Then the cataract is removed with a cryo-extractor (a cryoprobe whose refrigerated tip adheres to and freezes the lens tissue so it can be removed). It is now primarily used to remove subluxated lenses.



lapalmaeye.com

It was critical that the lens remained intact when it was being removed, so surgery was restricted to "*ripe* cataracts". This was a lens that was so hard that it would not break while it was being removed.

This limited the surgery to only the most advanced cataracts. Todays 10-0 suture did not exist so patients were immobilized with *sandbags* around their head while they healed flat in bed. This caused a reported high post operative death rate from pulmonary emboli.

liyamusic.com

Aphakic Correction After ICCE

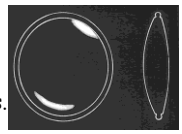
Aphakic glasses can treat their optical deficiency and may even give the patient good vision (20/20) but there are major disadvantages.

The lenses are thick, converging lenses that cause the retina to see a magnified image (up to 30% larger) and causes a reduced visual field (issues with driving). **"The jack in the box"** phenomenon also occurred causing a great deal of frustration for patients.

Contact lenses were also an option because they are **optically** more desirable. The image magnification is less and the visual field is greater. But, a major disadvantage occurred regarding insertion and removal of the lenses elderly due to their poor vision and decreased hand flexibility (either due to age or arthritis). These also tended to be large scleral lenses which were difficult to insert.

Sir Harold Ridley

Was an English ophthalmologist that invented the intraocular lens. During World War II, Ridley treated Royal Air Force pilots that had eye injuries. He noticed that when splinters of Polymethylmethacrylate (PMMA) from the cockpit canopies became lodged in the eye, it did not trigger a rejection response as glass splinters embedded often did. He later proposed the use of artificial plastic lens implants in the eye to correct cataracts. November, 1949, Dr Ridley performed the first intraocular lens implant.



Courtesy of Rayner Intraocular Society

Advantages Pseudophakia vrs Aphakia

IOLs were FDA approved in 1981.
Traditional IOLs are **monofocal**, giving vision at one distance (far, intermediate or near). This has been improved with the advent of the multifocal IOL's.
An eye with an IOL (pseudophakic eye) is optically very similar to a normal eye - you can in most cases see well without glasses. There is no significant magnification issues so you can have a cataract removed in one eye without having image/image size disparities between the two eyes.

Multifocal IOL's

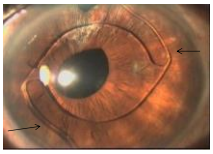
floridaeyegroup.com

Intra-Ocular Lenses: IOLS

Intraocular lenses are used to replace the eye's natural lens that is removed during cataract surgery. In 1981, the the first FDA approval for this type of products was issued. This new innovation changed the optical world drastically; replacing aphakic eyeglasses /or contact lenses with the patient wearing "everyday" eyeglasses or in some cases, not having to wear glasses at all. The main types of IOLs that now exist are divided into monofocal and multifocal lenses.

hollows.org.au

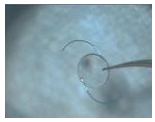
Anterior Chamber IOLS



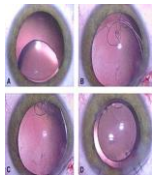
The main advantage of most secondary AC IOLs is the relative ease to perform the surgery and that performing the surgery is minimally traumatic to the eye.
Older AC IOL designs had a poor track record due to their rigid closed loop design. This design often caused erosion into the angle, pain, corneal edema caused by damage to the corneal endothelium, iris/pupil distortion and potentially endophthalmitis. The newer designs have flexible, open-loop haptics that are considered to be safer and give better long term visual outcomes.

online-eye-info.com

Posterior Chamber IOLS

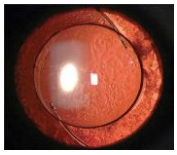


Also known as Sulcus Supported Intraocular lenses (IOL), consists of securing the IOL in the ciliary sulcus as a replacement for the natural lens. In the 1970s, John Pearce developed microsurgery, with the IOL placed in the posterior chamber. There was one disadvantage that came to light. Capsular epithelial regeneration caused clouding of the bag. With the development of the YAG capsulotomy – the bag can be opened by laser.



oculist.net

YAG

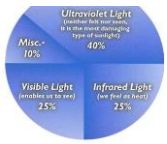


retinalphysician.com

drmalcolmmckellar.co.nz

The remaining portion of the capsule will become cloudy in about 25% of cataract surgery patients. This is sometimes referred to as a "secondary cataract," This is a misnomer. Once a cataract is removed, it does not regenerate.
YAG capsulotomy can pose additional risks (retinal detachment) although the actual procedure is very safe.
Statistics show that the lifetime risk of retinal detachment following cataract surgery is about 1%. That number rises to about 2% following YAG laser capsulotomy.

Ultraviolet Lenses

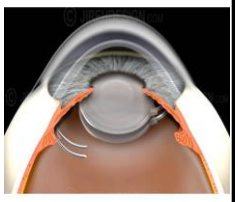


Some of the new IOLs provide ultraviolet and blue light protection. Your natural lens filters ultraviolet rays from hurting the retina. Many premium IOLs are designed to do this as well. Some studies show that these lenses have also been associated with some decrease in the quality of the vision. As we age, the lens gradually begins to yellow, further decreasing the amount of blue light that reaches the retina. It has become a standard of care to use UV absorbing IOLs.

tintdoctorhawaii.com

Piggyback IOLS

In some cases, the doctor may decide to insert an additional lens over an already implanted one. This procedure is called a "piggyback" IOL and is usually considered an option whenever the visual result of the first implant is not optimal. In such cases, adding another IOL over the existing one is considered safer than replacing the initial lens.



jirehdesign.com

Monofocal

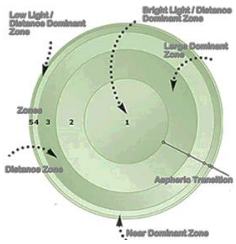
Monofocal IOLS are the traditional IOLS and give vision at <u>one distance only</u>: far, intermediate, or near. Patients who opt for these IOLS versus Premium (Multifocal IOLS) will need to wear glasses or contact lenses for reading or using the computer. These IOLS are usually spherical.

Monofocal IOLs	Multifocal IOLs
• Provides good vision at one distance (typically far vision)	• Corrects vision for near, far, and intermediate distances
• Requires reading glasses after surgery	• May eliminate or reduce the need for glasses altogether
• Covered by insurance	• Partial coverage by insurance (consult with staff)

pacificeye.com

Multifocal

These IOLS are often referred to as "premium" IOLS because they are multifocal and accommodative. They allow the patient to see objects at more than one distance, removing the need for glasses or contact lenses. Premium IOLS are used for correcting presbyopia or astigmatism.



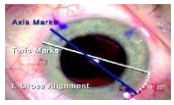
vodvos.com

Toric

STAAR Toric IOL

IOLS used to correct astigmatism are called Toric and have been FDA approved since 1998. In order to achieve the most benefit from a toric lens, the surgeon must rotate the lens to be on axis with the patient's astigmatism. Intraoperative Wavefront Analysis can be used to assist the doctor in toric lens placement and minimize astigmatic errors.

Alcon Acrysof IQ IOL

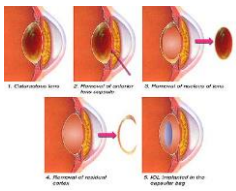


eyeworld.org

online-eye-info.com

ECCE
Extracapsular Cataract Extraction

Now the most common cataract procedures are : **Phacoemulsification** (phaco) and (2) different types of **ECCE**. Foldable lenses are usually used with the 2-3mm phaco incision, and non-foldable lenses are placed through the larger extracapsular incision. The small incision phacoemulsification (2-3mm) usually has a "**sutureless**" incision closure. ECCE uses a larger incision so it requires suturing. This has since led to the modification of ECCE : manual small incision cataract surgery (MSICS).



envisioneyemichigan.com

The lens of the eye is removed, but the capsule "bag" remains intact.

ECCE involves making a **small** incision near the limbal edge, and then entering the eye. The front of the lens capsule, is then opened through a "**capsulorrhexis**" (small circular tear). Using a "can opener" approach with a small bent needle, you make a small incisions around the anterior surface of the lens. This makes a continuous hole that the lens can be removed through. The nucleus is removed by applying pressure . Suction is then used to remove the lens cortex.

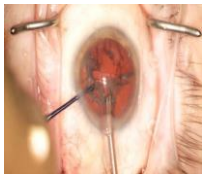
vimeo.com

Viscoelastic is inserted into the empty lens capsule to maintain its form as the IOL is being implanted. Then the viscoelastic is removed after the IOL is in place. The back of the lens capsule remains intact in the eye and assists in supporting the new IOL. The incision is closed/sealed and protected using two to three stitches. Visual recovery after ECCE is often longer than phaco, and because the cataract is removed in one singular piece, the incision is much larger, which can cause greater post op discomfort.

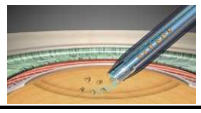
cimatechinc.com

Phacoemulsification: "Phaco"

Phaco is a refinement of ECCE and was created in the 1960s by Dr. Charles Kelman. It is the most common cataract technique used today.
It involves the use of a machine adapted with an ultrasonic hand piece that has a titanium or steel tip. The tip vibrates at the ultrasonic frequency of 40,000 Hz and the lens material is **emulsified**. A second instrument, sometimes called a "*cracker*" or a "*chopper*", can be used from a different incision to facilitate cracking, or chopping , the nucleus into smaller pieces.

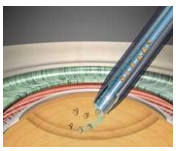


vimeo.com

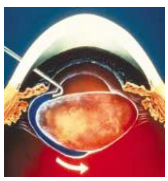


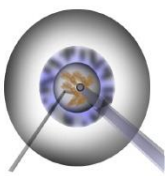
eastmichiganeyecenter.com

Viscoelastic fluid is inserted . Capsulorrhexis is performed. The cataract is separated from the cortex by using a water stream. The ultrasonic probe emulsifies the cataract, which is then suctioned out. As the cataract is being emulsified, it is also being extracted through a small hole in the tip of the phaco probe. The cortex is taken out, but the posterior capsule is left to hold the IOL. Fragmentation into smaller pieces makes emulsification easier, as well as the aspiration of cortical material. After phacoemulsification is completed, a dual irrigation-aspiration (I-A) probe is used to aspirate out the remaining cortex.



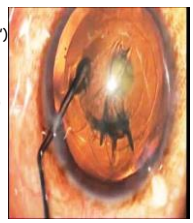
There were early complications with phaco . Corneal edema was a significant problem, and there were frequent difficulties in maneuvering the lens nucleus into the anterior chamber.
Dr Richard Kratz, and Dr Robert Sinskey developed variations to the phaco method. They relocated the emulsification action away from the endothelium to protect the cornea.
It is crucial to ensure that the endothelium is protected and does not receive any type of "trauma" during surgery.





It was found that it was very difficult lifting the entire lens nucleus out of the capsular bag. So a number of doctors began to develop methods for dividing the nucleus and moving the pieces from the bag into a deeper portion of the anterior chamber for safer emulsification.
Hydrodissection evolved as a means of moving and rotating the nucleus in the capsular bag. Dr Howard Fine developed the "chip and flip" lens removal which quickly gained popularity.

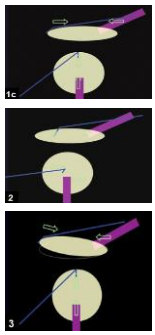
Dr Nagahara (the "father of chopping technique") used high vacuum ultrasound to impale the lens nucleus, and attached the emulsification tip firmly to the nucleus. The surgeon simultaneously places a sharpened tool (chopper) near the equator of the lens and draws it toward the phaco tip in order to *chop* or *slice* the lens into smaller pieces before emulsifying and aspirating them. Other surgeons modified this "full chop" to create "quick chop." Each method has its advantages and disadvantages, but the ultimate goal is to reduce the amount of ultrasound energy that the anterior segment is exposed to. Another method by Dr Paul Koch, MD, was called "stop and chop".

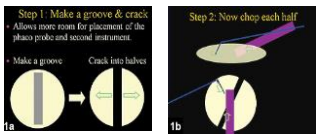


shelf3d.com

Stop and Chop Technique

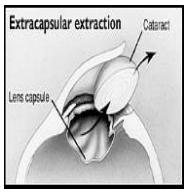
The phaco probe is embedded into the nucleus and the chopper is passed toward the lens equator. Once at the lens equator, the chopper is brought toward the phaco tip. It is this action of moving the chopper and the phaco tip together that does the chopping.





healio.com

Phacoemulsification is the most commonly performed cataract procedure in the developed world but due to the high cost of the phaco machinery and the disposable equipment means that ECCE and MSICS still remain the most commonly performed procedures in developing countries.

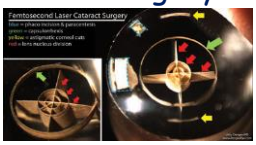


bme240.eng

Small Incision (SICS) Sutureless Non-Phaco Cataract Surgery"

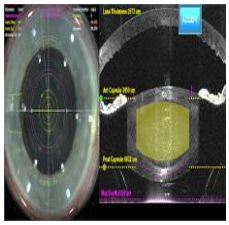
Phacoemulsification is the most widely used cataract procedure, many ophthalmologists use non-phaco small incision surgery in developing countries which can be just as effective when done correctly. A small, self-sealing incision is used to astigmatism. The "small" in the title refers to the wound being much smaller than an ECCE, although it is still larger than an average phaco incision. The nucleus is prepared within the eye for extraction, and then removed carefully to prevent damage to the cornea and posterior lens capsule.

Femtosecond Cataract Surgery



The purpose of using the laser is to assist /replace a number of *manual* aspects of cataract surgery. These include: creating the initial incisions in the cornea, creating the capsulotomy, and the initial fragmenting of the lens. The femtosecond laser can also be used to make the limbal relaxing incisions in the peripheral cornea to correct/ prevent astigmatism.

healio.com



The technology has been most notably used in LASIK. In FemtoLASIK, the laser replaces the microkeratome to create the corneal flap so the eye can have the secondary laser ablation to change the patient's refractive error.

Femtosecond laser for cataract surgery was first used by Professor Nagy in Budapest, Hungary in 2008.

visioneyeinstitute.com

Controversy Regarding The Femtosecond Laser

"You've got a technology that's going to increase the cost of a procedure and you've got to look at whether the increased cost translates into an increased benefit," Dr. Hoffman said. "For instance, when we went from radial keratotomy [RK] to photorefractive keratectomy there was an increased cost, but the benefit of that new technology made it worthwhile"
"Clearly, if we find out that the outcomes with the femtosecond are much better than they are with existing technologies, that's going to start to make a very strong case for implementing the femtosecond standard-of-care," Dr. Banja said

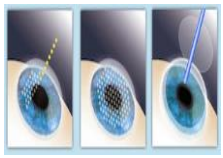
AT A GLANCE

- Femtosecond technology for cataract surgery poses several ethical problems for practitioners
- Practitioners must weigh whether increased cost translates into increased benefit for patients when urging femtosecond use for cataract removal
- The ethics of up-charging for premium IOLs or PCRIs to offset cost may in some cases be questionable
- When marketing femtosecond cataract surgery, it's important that practitioners resist the hype and not overstate the data

eyeworld.org

Femtosecond Uses

Femtosecond laser currently has four applications in cataract surgery:

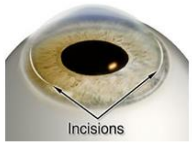


- astigmatic limbal relaxing incisions (LRIs)
- corneal wound construction
- anterior capsulotomy (or laser-incised capsulorhexis)
- lens fragmentation.

It is believed by some that femtosecond laser in these four areas will lead to surgery becoming faster and safer, with better visual outcomes.

Soroudi Advanced Lasik & Eye

Limbal Relaxing Incisions

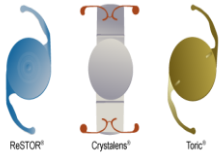


Manual LRIs can be technically challenging, due to concerns related to inaccuracy and the small risk of corneal perforation. Therefore, only a small proportion of patients who could benefit from LRIs are actually receiving them. Femtosecond laser-assisted LRIs may allow for optimum correction of low astigmatism, rendering conventional and somewhat unpredictable, manual LRIs obsolete. For higher degrees of astigmatism, however, it is likely that toric IOLs will continue to represent the best treatment modality.

Doctor-hill.com

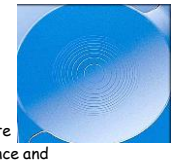
Premium IOLS

In the past, the only available IOLS were the standard, single focus aspheric **monofocal** IOLs (example Tecnis IOL) that were a fixed focus lens designed to give good distance vision. Monofocal IOLs did not correct astigmatism either.



Premium Multifocal IOLs are designed to give good distance, intermediate and near vision. There may be an adjustment period (up to six to 12 weeks) for the brain to adapt to seeing near and distance . There also may be complaints of halos /glare while getting used to the IOL.

Premium Multifocals: ReSTOR



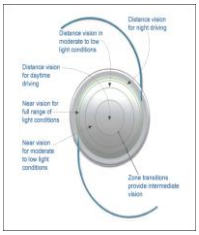
Uses a combination of an **apodized** diffractive and refractive lens to focus light. ***Apodization*** is the gradual tapering of diffractive steps from the center of the IOL to the outside edge to create a smooth transition of light between the distance and near focal point. This means these steps work together to focus light for near and distance vision.

Two versions of the Alcon AcrySof IQ ReSTOR IOL now are available. The original non-aspheric version, approved in March 2005 and in 2008, a newer version was approved. This version has a different near power zone of +3.00 diopters, which gives much better vision at **intermediate** distances. The original version had a +4.00 diopter power that gave better *near vision*, but had less emphasis on the intermediate vision.

vision-surgery.com

Premium Multifocals: ReZoom

ReZOOM (Abbott Medical Optics or AMO) has multifocal zones that *focus light* simultaneously. It is divided into five different light and focal distances. Is known for it's enhancement of intermediate vision.



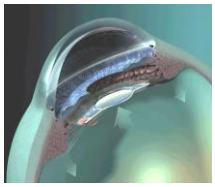
berkeleyeye.com

Premium Mutlifocal IOLS Tecnis

From AMO: Like the IQ ReSTOR, the Tecnis also uses a diffractive lens designed to direct light in different ways depending on the different zones in the lens. Excellent for low light situations, such as driving at night.

worldclasslasik.com

Premium Multifocals: Crystalens



Crystalens (Bausch + Lomb) is the first accommodating IOL to be approved by the FDA. Other IOL's are fixed and stationary in the eye. Crystalens is engineered with a hinge design that moves with the ciliary muscles .This allows for movement of the center optic back and forth as the patient changes their focus. This movement gives clear vision at distance and intermediate. Near distances may still be out of focus. Advantages: are less night glare and sharper contrast. Disadvantage: most patients will still need reading glasses.

katzeneyecare.com

Insertion of IOLs

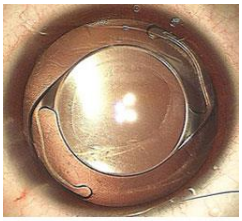
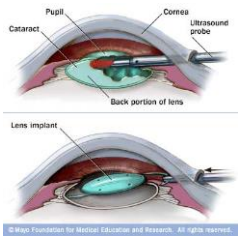
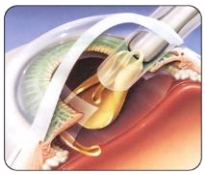


Fig. 2 Intraocular lens in place.

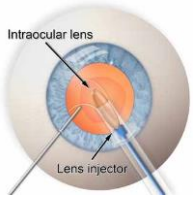
aapos.org



Mayo.org



Biloxilasik.com



symbiosisbilling.com

Good Multifocal Candidates

- Younger cataract patients with good general eye health and active lifestyles that want to eliminate the need for glasses.
- Patients with presbyopia and near problems secondary to hyperopia.
- Patients with high levels of myopia. Because they have had to wear glasses in the past for good vision, multifocal IOLs, even with some distortions, are usually greatly appreciated

Exclusions for Multifocals

aoa.org

- High amounts of astigmatism that can't be corrected easily with limbal relaxing incisions or refractive eye surgery.
- Eye problems i.e retinal problems
- Emmetropia prior to cataract surgery. Patients that have good vision prior to cataracts find any kind of visual distortion related to multifocal IOLs unacceptable.
- People with low to moderate myopia.

The vision improvements may not be significant enough to make up for the possible visual distortions associated with multifocal IOLs