Cataracts and the Intraocular Lens

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Introduction and Background

Cataracts are an issue that many of us will experience. A cataract is a clouding of the eye's natural lens. With age, the eye's natural lens hardens, and it can yellow or become hazy and cause visual impairment. Some cataracts can also be caused by trauma to the eye, or someone could be born with one. In order to remove the cataract, the entire natural lens of the eye must be removed. In order for someone's vision to be restored, the natural lens is replaced by an artificial intraocular lens, or an IOL.

The first cataract surgeries were believed to have taken place as early as 600 BC. Many early procedures were not as safe or effective as today's, with some of the best success rates to be only 50%. Even though today's success rates are around 95% in the United States, some of the same techniques are still used. Extracapsular cataract extraction, or ECCE, is one of the most common techniques used today. The natural lens of the eye is encased in a capsule, similar to an M&M candy with the lens being the chocolate inside the shell. ECCE would remove the lens with the cataract while leaving the lens capsule in place. This technique allows the incision to be smaller than other techniques, which helps the healing process to be much easier for the patient. By keeping all or most of the lens capsule in place, the patient is able to receive an IOL. In some cases, the patient may not even have their lens removed. Some people with very poor vision could also receive an IOL as an alternative to other corrective procedures.

IOLs

IOLs come in many varieties for all types of eyes. They are very similar to contact lenses in some ways, except they are surgically inserted into the eye instead of being placed on the surface of the cornea. They are much smaller than contacts, though, being only a few millimeters wide. Like contacts and glasses, they have a prescription strength in diopters. IOLs are made of silicone, acrylic, or sometimes Collamer, so they can either be hard or more flexible. Some are inserted while folded, or they could be placed without being folded. IOLs also come in different shapes, having thin arms, loops, or a plate style extending from the central optical area. These three basic designs have countless options for how each piece is specifically shaped. Many follow a spiral shape, like a galaxy, but some are more rectangular and symmetrical.

Intraocular Lens Examples

1.00 mm

Figure 1. An Alcon MTA4U0 lens. This is a 10 diopter lens, 13.0 mm wide, with the optical center being 5.5 mm in diameter. This lens is made of Polymethyl Methacrylate and cannot be folded to be inserted.

1.00 mm

Figure 2. An Akreos Bausch and Lomb AO60 lens. This is a 3 diopter lens, 11.0 mm wide, with the optical center being 6.2 mm in diameter. This lens is made of hydrophilic acrylic. It is stored in a solution, where it is very flexible, then it hardens as it dries.

Surgical Preparation

Once you and your doctor have decided that it would be best to get cataract surgery, you will go to the clinic to get some scans and measurements taken. Depending on the doctor and certain results, the types of testing may be different for each person. IOL measurements will definitely be taken, which include the anterior chamber depth, or how long the eye is from the cornea to the iris and pupil, the corneal thickness, the cornea's diameter, the total eye length, and the amount of astigmatism. This is all done on one machine called an IOL Master with only a few images of the eye, and it usually only takes a few minutes.

The next machine will usually be a corneal topography. The cornea is responsible for about 70% of the refraction that gives your eye a focused image. Because it is such an important part of sharp vision, a map of the cornea's surface is usually very helpful when selecting IOLs. The cornea is also responsible for any astigmatism you might have. The topography would be able to locate where the astigmatism is, and it can get a more accurate reading of how much astigmatism there is than the IOL Master can. In cases of high astigmatism, there are special lenses, called toric lenses, that are able to correct for that.

Lastly, you may get an OCT, which stands for optical coherence tomography. This machine scans your retina, which is the back of the inside of the eye where all of the light detecting cells live. This type of scan is important because the doctor is able to look at how healthy your retina is. This could show them any additional reasons why your vision may be blurry. It is also important to know your retinal health because the surgery may put you at risk for a retinal detachment.

The surgery itself is short, and you will be going home the same day. It is usually done with a sedative rather than general anesthesia, so you will most likely be conscious but not remember too much. This helps with the stability of the eye during the procedure and allows it to go quicker. Recovery may be different for everyone. Depending on the lens your doctor has selected, the size of the incision needed, and the surgical techniques the doctor uses, you may or may not need stitches at the end of the procedure. You will most likely be given a protective shield or patch to wear after the surgery, and your doctor will discuss follow-up appointments to make sure there are no complications and to remove your stitches if necessary.

Observations

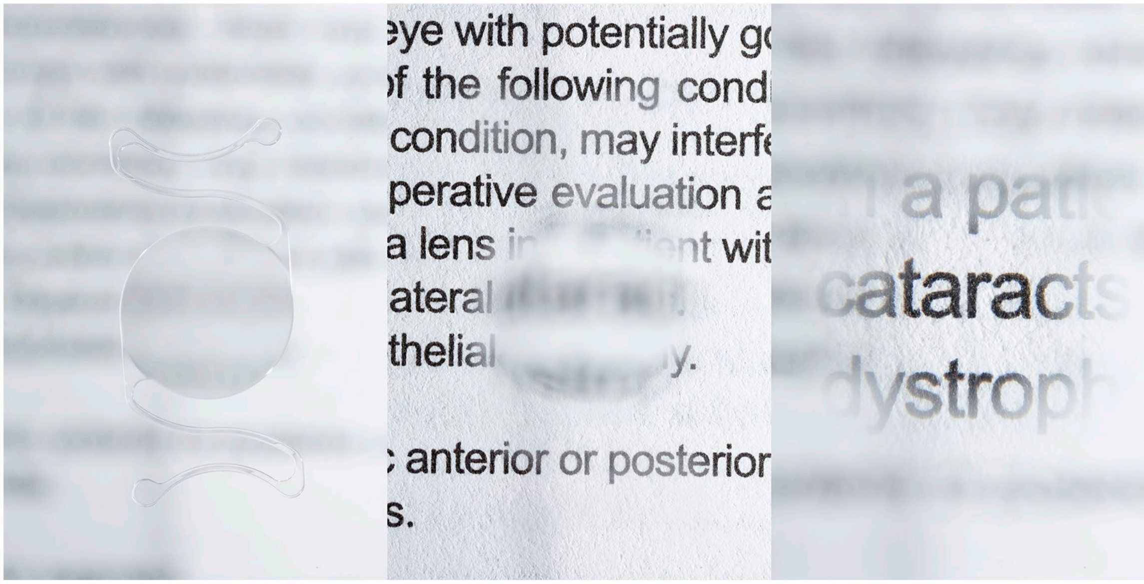

Figure 3. Alcon MTA4U0 10D lens demonstrating how something may appear with and without a corrective lens. The focus was changed by adjusting only the object distance, with the lens resting on a glass slide about 1.5 cm above the paper.

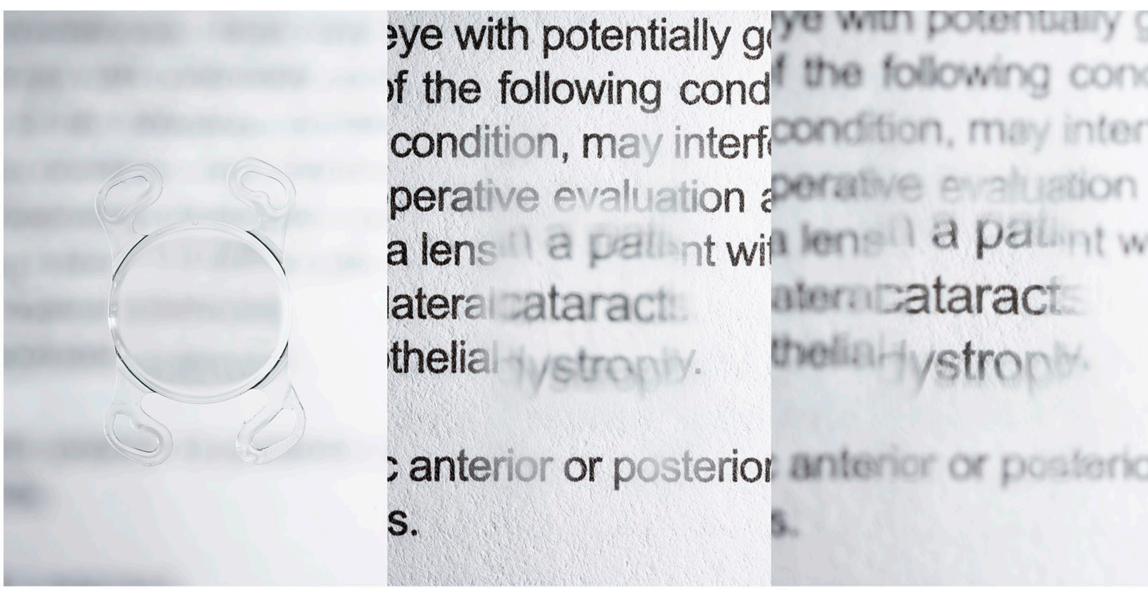

Figure 4. Bausch and Lomb AO60 3D lens demonstrating how something may appear with and without a corrective lens. The focus was changed by adjusting only the object distance, with the lens resting on a glass slide about 1.5 cm above the paper.

Figure 5. Alcon MTA4U0 10D lens haptic detail.

Figure 6. Bausch and Lomb 3D lens haptic detail. Shows scratches on surface due to handling after hardening.

Setup

The images used in this article were taken in a macro photography setup. I used a Canon 5D Mark III with a Canon 65mm 1-5x lens. The stage was created using a white sheet of plexiglass resting on wooden blocks. The samples were prepared by placing them on a clean glass microscope slide that was elevated about 1.5 cm by resting each side on small petri dish covers. Tungsten lights were used by illuminating the subject from below through the plexiglass. This is demonstrated in Figure 7 to the right. For Figures 3 and 4, the paper was placed beneath the slide, and the paper and sample were illuminated from above.

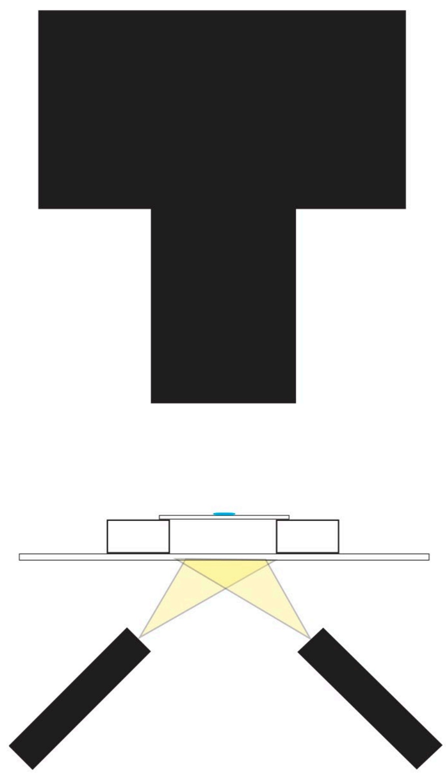

Figure 7. Camera setup.

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About the Author

My name is Cailey Shaughnessy, and I am a senior majoring in Photographic Sciences. I will be graduating in May 2023 with a Bachelor of Science. I originally started in a BFA Photography program at Lesley University before transferring after my sophomore year in 2020. I have always loved science and wanted to find a way to incorporate it into my work. At RIT, I have taken many interesting classes in ophthalmic photography, macro photography, programming, and optics. I was able to do my co-op at the Flaum Eye Institute, where I am still able to work part-time as a diagnostics technician. I also enjoy the technological side of my major, and would also be interested in pursuing a career in imaging technology.

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