Remembering Milestones and Achievements in Surgery: Inspiring Quality for a Hundred Years 1913-2012

American College of Surgeons
Inspiring Quality: Highest Standards, Better Outcomes
A century ago, ophthalmic surgeries would not have been popular topics for casual conversation. Procedures involved large incisions and long recuperation periods that often involved immobilization in devices for several days. Complication rates were high and visual rehabilitation limited. However, due to the determination of innovative ophthalmic pioneers, the past 100 years have witnessed tremendous advancements in intraocular surgery.

The first surgical procedures to cure blindness were devised more than 2,000 years ago. The operations to remove cataracts from the visual axis utilized thorns and forged needles, and were surrounded by great mystique. Despite a very high rate of failure, successes were so dramatic that early surgeons were treated with the greatest respect and honored throughout the land. Over the ensuing 20 centuries, cataract surgery has undergone extraordinary advances, especially in the past 100 years.

The nineteenth century set the stage for modern surgery with the introduction of germ theory and sterile surgery by German physician Robert Koch and British surgeon Baron Joseph Lister, after whom Listerine® was named. These discoveries dramatically improved the safety of surgical outcomes, and, coupled with major improvements in anesthesia and the refinement of vital surgical instruments such as the lancet blade, have resulted in much safer and less invasive procedures that can treat a wider variety of diseases and yield better outcomes for surgery patients.

Herein, I shall discuss five key areas of innovation that have most dramatically revolutionized ophthalmic surgery over the past century.

**Intraocular Lens**

For eyesight to be possible, light entering the human eye must first be refracted at the air-tear interface of the cornea and then focused by the crystalline lens onto our retinas. Next, photoreceptors within the retina convert that light into electrical impulses of information, which are transmitted through the optic nerve to our brains, where the perception of vision is created. When we are born, the lens is clear as glass. But, as the lens ages, it begins to lose its flexibility and undergoes natural changes to its structure that cause yellowing and opacification, ultimately leading to a decreased ability to see.

For a long time, the only way to deal with a visually significant cataract was for a surgeon to stick a needle into the eye and displace the lens out of the visual axis. With the advance of ophthalmic surgery, physicians later devised methods for removing the cataractous lens, but there was a problem: What would take the place of the lens? Removing an opaque lens meant condemning a patient to half-inch-thick glasses that did a poor job of replacing the lens’ ability to bend light. Innovation was needed, and it took one brilliant man to change the course of ophthalmology.

During World War II, ophthalmologist Harold Ridley, MD, was treating eye injuries in Royal Air Force pilots. He noted that when fragments of acrylic plastic from cockpit canopies were embedded in patients’ eyes, they were tolerated without inflammation,
rejection, or any apparent toxicity. He wondered, what if he made a lens from this acrylic to insert in the eye?

It was a bold idea with limited acceptance from his colleagues. He pressed on, however, and introduced the first intraocular lens (IOL) at the end of 1949. “In doing so, he changed the practice of ophthalmology,” note Drs. David J. Apple and John Sims in their biography of Ridley for *Survey of Ophthalmology*. “Not only [did] Ridley’s invention provide superior visual rehabilitation to cataract patients for generations to come, but also, without his having realized it, the IOL has been a major factor in changing the way ophthalmology is practiced.” For his remarkable accomplishments in ophthalmic medicine, Dr. Ridley was knighted Sir Harold Ridley by Queen Elizabeth II in February 2000.

Initially, a patient had to be close to legally blind before a surgeon would perform cataract surgery because early IOLs were associated with higher complication rates. There were also concerns over their long-term effects on eye health. Over the years, however, continued refinement in IOL materials, shape, and surgical method led to their widespread acceptance with significantly better outcomes than leaving patients aphakic. Following the introduction of foldable IOLs, the age of small-incision cataract surgery was born, and today’s ophthalmic surgeons are able to operate on patients as soon as they feel limited by their vision. What was once a risky and imperfect procedure has thus evolved into a low-risk and highly satisfying surgery for both patient and surgeon.

**Microsurgery**

The introduction of microscopy created the field of microsurgery and revolutionized ophthalmic surgery. A few key advances highlight the path to where we are today.

In 1956, José I. Barraquer, MD, of Buenos Aires, Argentina, pioneered the idea of adapting surgical microscopes for suspension from the ceiling, an approach ophthalmologists needed in order to keep their patients lying in a supine position. This enabled proper stabilization and positioning of patients, which was a key prerequisite to numerous future innovations in ophthalmic surgery.

In the 1960s, Richard C. Troutman, MD, of New York approached German manufacturer Zeiss Oberkochen to develop a zoom microscope with variable ranges for use in his practice and at New York Hospital. When he demonstrated it at an American Academy of Ophthalmology meeting in 1965, the implications of what he had achieved were obvious and he was met with immediate acceptance and praise. Subsequent advances have included variable wavelengths of illumination, integrated laser capabilities, voice-activated adjustments, improved depth of focus, high-definition and 3-D video recording, and conferencing. These advances facilitate the creation of online surgical libraries, real-time education in adjacent or distant viewing sites, and innovative telesurgical applications.

Each incremental improvement in microsurgical tools and techniques is built upon its predecessors, allowing for the implementation of new techniques and refinement of old ones. As a result of the last 100 years of progress, most major eye surgery in developed nations around the globe is done with operating microscopes, facilitating new surgical techniques and improving patient outcomes.

**Phacoemulsification**

In the 1960s, Charles Kelman, MD, couldn’t turn off his brilliant mind even while in the dentist’s chair. He was fascinated with the ultrasonic device that cleaned his teeth and began asking himself, if sound waves can break up plaque, why couldn’t they do the same to a cataract? At that time, cataract surgery involved cutting 180 degrees around the eye before removing the lens with a freezing cryoprobe. Recovery was lengthy and postoperative complications were borderline routine.

In 1967, Dr. Kelman introduced phacoemulsification, using ultrasonic energy to emulsify the lens and then aspirate it through a tiny vacuum. It was a very crude procedure in the beginning with limited support from
his colleagues. That he was able to pioneer such a radical new approach is nothing short of amazing. It is said that he secretly performed his first phacoemulsification test on a blind man behind a closed door with a sign that read, “Contaminated Room—Do Not Enter.”

Today’s cataract patients have Dr. Kelman to thank for his persistence. Like me, my father was an ophthalmologist, and I remember as a child rounding on his postoperative patients in the hospital where he worked and seeing dozens of cataract patients whose heads were immobilized by sandbags for four or five days. Dr. Kelman changed all that. By contrast, today’s cataract surgery is an outpatient procedure with a short recovery period and rare complications. Modern phacoemulsification devices and our surgical techniques are extremely sophisticated, shunning the 4-pound hand pieces of the late 1960s and 1970s for a constantly evolving set of tools that will continue to be modified to yield even better outcomes for our patients.

Vitrectomy

Most of the eye’s volume is composed of a substance termed the vitreous. Like the lens, vitreous changes with age. When we are born, it is gelatinous and flexible, but as we age it liquefies and eventually separates from the retina. It was once believed that touching the vitreous of the eye risked retinal detachment and total loss of vision. Because of this, surgically removing the vitreous was always considered dangerous and foolhardy. But then, in 1968, David Kasner, MD, reported successful extraction of diseased vitreous in a case of amyloidosis, becoming the first surgeon to demonstrate that removal of diseased or prolapsed vitreous is tolerated by the eye.

However, it was Robert Machemer, MD, at Bascom Palmer Eye Institute who buried the erroneous notion once and for all. In 1969, he invented a miniaturized, motor-driven cutter and, working with Jean-Marie Parel, PhD, a year later, a suction cutter that would fit into a small hole and act as a guillotine to aspirate the vitreous jelly. Coupled with continuous infusion of solution, this technique marked the beginning of a revolution in vitreous microsurgery.

The foot-pedal-controlled aspiration system was developed by Drs. Conor O’Malley and Ralph Heintz in 1971. Then, in the early 1980s, Steve Charles, MD, FACS, introduced xenon endophotocoagulation, in which a fiber-optic probe is positioned near the retina after a vitrectomy to treat retinal breaks, stop retinal bleeding, coagulate neovascularization, or manage a number of other complications, dramatically improving surgical outcomes. Numerous innovative vitreoretinal surgeons have continually improved the designs of these tools to include variable flow control, disposability, refined ergonomics, and other remarkable advancements that have paved the way to modern vitreoretinal surgery.

Again, what was deemed impossible a century ago has become routine. These pioneers have established removal of vitreous as a safe and reliable procedure, leading to hope for millions of patients suffering from vitreoretinal diseases. Although it is impossible to quantify exactly how many patients have had their vision saved or restored by vitrectomy, the enormity of its impact is unmistakable.

Lasers

More than a dozen types of lasers are used in modern ophthalmic surgery for different types of procedures. The precursor to the ophthalmic laser was the photocoagulator, invented in 1949 by Gerhard R. E. Meyer-Schwickerath of West Germany, whose experiments resembled those of Dr. Frankenstein. He observed numerous patients who were blinded by staring at the sun, and he hypothesized that this power, if carefully harnessed, could be used to destroy diseased tissue. He would bring patients to a room on the top
floor of his clinic, where the ceiling opened. On sunny days, he would use a series of mirrors to direct and magnify the sun’s rays to treat—and burn—areas of the retina. The technique proved very effective for diabetes complications and was useful for certain aneurysms and tumors in the eye. Today, ophthalmologists use a variety of laser wavelengths to treat retinal diseases such as diabetic retinopathy. Hundreds of thousands of diabetic patients have had their vision saved by retinal photocoagulation.

In the 1950s, xenon lamps began to be used as the light source for photocoagulation, eliminating the need for a hole in the roof. When the ruby laser was invented at the end of that decade, it was found effective in producing adhesive chorioretinitis, but was not useful in treating vascular diseases. However, as laser science rapidly developed, so did its ophthalmic surgery applications. Francis L’Esperance, MD, conducted the first photocoagulation with an argon ion laser at the Edward S. Harkness Eye Institute in 1968, which was highly successful and led to widespread applications for treating an array of vitreoretinal diseases. In 1971, the krypton laser was found to be even more effectively absorbed by pigments of the eye, but producing the beam was technologically difficult and cost prohibitive.

The development of the yttrium-aluminum-garnet (YAG) laser in 1978 was the next revolutionary step in the development of laser eye surgery. When Danièle S. Aron Rosa, MD, first presented her results, she was widely criticized and rejected by colleagues. Over a decade, however, her work was finally accepted and she became an internationally renowned figure in ophthalmology. Instead of burning, her laser beam precisely cut or vaporized without damaging surrounding tissue, solving a difficult complication of modern cataract surgery: following cataract removal and intraocular lens placement, the capsular bag containing the new man-made lens may grow gradually opaque. Before the YAG laser, ophthalmic surgeons did not have a safe, non-incisional treatment to restore vision lost as a result of this secondary posterior capsular opacification. Now, a 5-minute YAG procedure restores this lost vision without a surgical incision in the eye.

Another wave of innovation began with the excimer laser, patented by Steven L. Trokel, MD. This laser is capable of reshaping corneas to correct nearsightedness and farsightedness. It was originally used by IBM® to cut silicone chips at its New York facility in the 1970s. Rangaswamy Srinivasan, PhD, James Wynne, PhD, and Samuel Blum, PhD, who worked in the IBM research labs in 1982, recognized its potential in medical applications, but it was Dr. Trokel who first applied the excimer laser to cornea surgery. This paved the way to LASIK and photorefractive keratectomy (PRK), which remain tremendously popular elective surgeries for those patients wishing to do away with corrective lenses.

The femtosecond laser marks the next major advancement driven by new laser technology. As this safer and more effective transpupillary laser system is perfected and fully integrated into cataract surgery, we will see postoperative outcomes improve beyond even the excellent results currently achieved by modern vitreoretinal surgeons.

Conclusions

Thanks to the creativity and perseverance of innovative ophthalmic surgeons, the past 100 years have seen remarkable developments in technology and technique that have led to reduced recovery times and improved outcomes for patients. World-changing advances have been made in the areas of intraocular lenses, microsurgery, phacoemulsification, vitrectomy, and laser surgery. Modern surgery is performed in ways unimaginable a century ago. As we train the next generation of ophthalmologists to lead us into the future, one wonders what new developments may unfold over the next 100 years.

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