Evolution of Cataract Surgery

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The development of modern cataract surgery has been a concert of evolving ideas and technologies. A discussion of the history of cataract surgery may have no one single defining moment, but rather a group of important events which historians use as landmarks.

Cataract surgery by "couching" (lens depression) was, without a doubt, one of the oldest surgical procedures. This technique involved using a sharp instrument to push the cloudy lens to the bottom of the eye. Maharshi Sushruta, an ancient Indian surgeon, first described the procedure in "Sushruta Samhita, Uttar Tantra", an Indian medical treatise (800 B.C.). This text describes an operation called "couching", in which a curved needle was used to push the lens into the rear of the eye and out of the field of vision. The eye would later be soaked with warm clarified butter and then bandaged. Sushruta claimed success with this method but cautioned that this procedure should only be performed when absolutely necessary. This method may have been brought to the West by Greek travelers from India and the Middle East. The removal of cataract by surgery was also introduced into China from India. The procedure, also known as jin pi shu in Mandarin, was introduced to China via the Silk Road during the late West Han Dynasty (206 B.C.-9 A.D).In the Western world, bronze instruments that could have been used for cataract surgery have been found in excavations in Babylonia, Greece, and Egypt. In Rome, Celsus (25BC-50AD) practiced couching by slim flat needles. Pliny (23-79 AD) recorded that Hyoscyamus (Henbane, an atropine like herb) was used to dilate the pupil for couching. Galen (131-210AD) wrote that evacuation of the lens was attempted by suction.

The Extracapsular technique was predominant from 1749 to the early 1900s. The first true extra-capsular cataract surgery was by Daviel in Paris in 1748, using an inferior incision by needle knife, or a keratome and curved scissors, to access and remove the lens nucleus. Inferior section was a natural operative choice for a patient seated and held by helpers; Bell's phenomenon would naturally turn the eyes up; the gush of aqueous irrigating both lens cortex and bacteria outwards. The anterior lens capsule was opened, either by toothed forceps (Arruga) or by being incorporated in a single action Graefe knife sweep through the cornea and lens capsule. By the mid 20th century, surgeons were closing the wound with one to three virgin silk sutures, swaged onto atraumatic hollow tailed needles that greatly reduced suture reactivity. Extra capsular surgery continued for patients under the age of 40, because of their stronger zonules, even after the introduction of intra-capsular extraction.

The intra-capsular technique was introduced in 1880. After section and iridectomy, and with the pupil dilated, the lower part of the anterior capsule was grasped by forceps and by a variety of rocking manoeuvres the zonules were weakened and broken from the ciliary muscle (usually without rupture of the capsule). The lens was then delivered upside down by an action known as tumbling. Excess pulling could cause either capsule rupture or vacuum at the vitreous face, which might rupture and cause macular oedema and subsequent retinal detachment. Barraquer introduced Zonulysin (i.e. alpha chymotrypsin, a digestive proteolytic enzyme of bovine origin), which could be injected into the posterior chamber before either method, as an aid to easier and safer lens delivery. Miniature suction

devices (Erisophakes) were an alternative method. Krawicz (1963) used a silver rod conducting cold from solid CO_2 in a syringe 'cryoextractor' in order to make adhesion to the lens more reliable. This technique was refined by Amoils (1964), who used the Joule Thomson effect to cool the cryoprobe which could then be reheated electrically, or by warm gas to release the probe if the resulting iceball also adhered to iris.

Belladonna Atropa (Deadly nightshade) was used to dilate the pupil from 1796 giving better visualisation and post-operative control of synechiae. Atropine was synthesised from this alkaloid in 1831 and cocaine anaesthesia (an improvement on laudanum) was used first in 1884, both topically and by injection. Improved manufacturing and metallurgy led to the development of better steel instruments during the 19th and 20th centuries.

The next advance for cataract surgery was the introduction of the operating microscope, first used for eye surgery by Dr Ken Swann in Portland, Oregon, in 1948. Magnifying near vision glasses and telescopic loupe glasses gave support to older emetropic and hypermetropic surgeons, allowing a better microscopic view of the operative field. This began the era of ophthalmic microsurgery. This was closely followed by another important watershed, the invention of the intraocular lens (IOL). Although the suggestion of using an optical aid (a magnifying glass) implanted in the eye dates back to the 18th century and is attributed to by Giacomo Casanova, Harold Ridley implanted the first IOL in 1948. He observed, along with other cataract surgeons, the disability experienced by those who had cataract surgery and who were required to wear convex spectacles to compensate for the lost converging power of the eye lens. The invention of the IOL was driven by the need to overcome the disability of the patient. Others later capitalised on this material to make lighter anterior chamber lenses (e.g. Strampelli, Choyce). In parallel, Charles Kelman (1967) adapted ultrasonic dental deplaque instruments to phacoemulsify the lens nucleus in the anterior chamber, allowing smaller incision extracapsular surgery. The technique has evolved to use low enough amounts of energy to split the nucleus into fragments without damaging the neighbouring structures of the eye. Several years of development were needed to bring phacoemulsification to its present day popularity. Refinements of the procedure have allowed the operation to be performed as a day case with full correction of vision. Complication rates are low and recovery is quick. Usually anaesthesia is with drops sometimes supplemented with a local injection if needed. Newer lenses are being developed continuously. These include lenses to correct for astigmatism, yellow lenses to block blue light, lenses that allow accommodation, those focus for near and for far distance and more recently light adjusting lenses. Within one working generation, the advent of smaller incisions faster rehabilitation and even safer surgery has become standard, transforming an ancient operation into the miracle of modern cataract surgery.

The next major step in the evolution of cataract and intraocular lens (IOL) surgery must surely be the use of femtosecond laser technology to automate several aspects of the process. Femtosecond technology should add predictability in preparation of an eye for lens evacuation and IOL implantation.