

The Genesis of Phacoemulsification

A look back by the originator of the technique.

BY CHARLES D. KELMAN, MD

Four years after my residency, I drafted a grant proposal to study the effects of freezing on the ciliary body, retina, and choroid. I went to bed concerned that the Hartford Foundation would not find the topic of interest, awoke in the middle of the night, and, almost in a trance, added an addendum to my application that would affect the rest of my life and the lives of 100 million patients: "in addition to the freezing studies, this investigator will develop a method for removing a cataract through an incision small enough so that no hospitalization will be required."

Mr. E. Pierre Roy, the head of the John A. Hartford Foundation, could easily have rejected my application and put an end to this matter. Instead, he had confidence in my abilities and gave me a 3-year grant, although I did not have the vaguest idea of how to realize my idea.

INITIAL STRUGGLES

Mr. Roy's confidence was misplaced for 2 years and 8 months, while I tried everything I could imagine. I first attempted to capture the cataract within a folding lens bag (Figure 1), crush it inside the bag with manual disintegrators, and then remove the device containing the fragmented lens material from the eye. The rotating devices I tried simply spun the cataract around inside the anterior chamber. High-speed cutting needles, a miniature blender, drills, tiny meat grinders, engraving tools—nothing worked. All the devices yielded opaque corneas in animal eyes.

I had meanwhile allowed my hair to grow down to my shoulders, and my teeth badly needed a cleaning. Sitting in my dentist's chair, I became interested in the ultrasonic tool he was using to clean my teeth. He explained that its high-frequency vibration removed tartar without disturbing the tooth itself. I raced out of his office with the bib still hanging around my neck and returned 1 hour later with a cataractous lens. Because I was able to engrave lines

on the lens without its jumping off my finger, I believed that I could break up a cataract inside the eye without its spinning or vibrating against the corneal endothelium.

Cavitron Corporation ultimately made a prototype with a handpiece that incorporated I/A (Figure 2), rather than only irrigation, as with the original dental instrument. My first efforts with this device resulted in opaque corneas until I began using a physiologic solution, imported from the Barraquer Institute in Barcelona, Spain, in place of the simple saline solution. I also realized that the high temperatures that the procedure created inside the eye would denature the corneal proteins.

After several months of successful animal testing, I operated on my first human subject, a man suffering from a painful blind eye due to burned-out glaucoma. The strong surge of suction caused the cornea to collapse 30 to 40 times during the 70-minute phacoemulsification. The next day, his eye was a bag of pus that had to be removed.

I spent 2 years seeking a way to prevent corneal collapse and finally found a company in North Carolina that manufactured a device that sensed arterial flow. Cavitron



Figure 1. One of the many unsuccessful devices created by the author for small-incision cataract surgery involved folding lens bags and manual disintegrators.



Figure 2. An early prototype of the phaco handpiece.

Corporation incorporated this feature into the phacoemulsification device's aspiration line with an air-relieved valve. If the speed of the current in the aspiration line exceeded the speed of the irrigation, then a valve opened to halt suction immediately.

One year later, I worked up the nerve to operate on the eye of a patient with central retinal artery occlusion and no light perception. If I had failed that time, I probably would have abandoned the project. A specially designed, three-dimensional micromanipulator supported the weight of the cumbersome phaco handpiece and steadied the phaco tip inside the eye for long periods of time. I deemed the operation a success when the patient achieved light perception postoperatively. The severe striae keratitis present on the first postoperative day subsided after 6 weeks.

HURDLES

The Hospital

At that time, there were no rules against performing new procedures. Nonetheless, after I had successfully completed a few more cases, the chief surgeon at Manhattan Eye and Ear Hospital tried to convince the board to rescind my operating privileges. Ultimately, they established a committee to oversee the results of every patient. Fortunately, by this time, my results were quite good.

The Profession

Although I began teaching phacoemulsification in 1970 with the first commercially available machine, the profession vehemently protested the adoption of the technique. Most if not all surgeons at that time used only loupes for magnification. As a result, they had to learn to use an operating microscope as well as to perform phacoemulsification. Many politically important ophthalmologists were older and either unwilling or unable to learn these new modalities. The fact that I, the technique's main pro-

ponent, was playing the saxophone and singing in the casinos of Atlantic City and appearing on the *Johnny Carson Show* did not help the cause (Figure 3).

The Companies

The lead engineer at Cavitron Corporation had encoded and threatened to withhold all the critical information about the new phacoemulsification machine in a play for a promotion to vice president around 1971. Cavitron Corporation fired him, but the company was then ready to abandon the project. Fortunately, Alan McMillan, an entrepreneur from California, took over the project and developed a new model, which he eventually sold to CooperVision (Fairport, NY) and, finally, Alcon Laboratories, Inc. (Fort Worth, TX).

The Study

The AAO initiated a major comparative study of phacoemulsification and intracapsular cataract extraction (ICCE). At my insistence, the chairman of the Department of Mathematics and Statistics at Columbia University in New York monitored the study's results. The investigators' reluctant conclusion was that phacoemulsification deliv-



Figure 3. The author was well known for his musical and comedic performances.

ered the same quality of results as ICCE, but the report's conclusion stated that ICCE was the preferred and only method to use in many instances.

The Classification

The next major attack on phacoemulsification occurred when opponents got the FDA to classify the procedure as experimental and, therefore, nonreimbursable. Reversing this decision required thousands of letters from patients and an appearance before the FDA by the renowned television doctor, Marcus Welby, MD.

The IOL

As IOLs became more popular in the late 1970s, many surgeons gave up on phacoemulsification, because implanting the lenses required larger incisions. The advent of lenses that could fit through a smaller incision, such as the Omnifit (Precision-Cosmet Company, Inc., and Heyer Schulte) and foldable IOLs, revived the procedure.

CONCLUSION

When I began performing phacoemulsification, no accurate way for measuring an eye's endothelial cell count existed. Although patients' corneas recovered, I am certain that the endothelial cell loss was unacceptable in very early cases. If I had not been in the right place at the right time and had an obsessive motivation, I believe we would still be performing ICCE.

I thank my colleagues, supporters, and collaborators. I also thank my opposition for inspiring me to try harder. ■

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