Bringing Keratophakia and Keratomileusis to North America

Adapting and disseminating Barraquer's concepts of refractive surgery.

BY RICHARD C. TROUTMAN, MD, DSc(HON), FACS, FRCOPHTH, AND CASIMIR A. SWINGER, MD

The conception and development of corneal refractive surgery by José I. Barraquer, MD, predated its introduction to the US by almost 30 years, during which time he painstakingly began implementing its principles and practice. Mutual interest in performing ophthalmic surgery under microscope magnification (a technique Drs. Barraquer and Troutman had initiated independently in the mid-1950s) first brought them together and eventually brought Dr. Barraquer's concepts of refractive surgery, keratophakia, and keratomileusis, to North America.

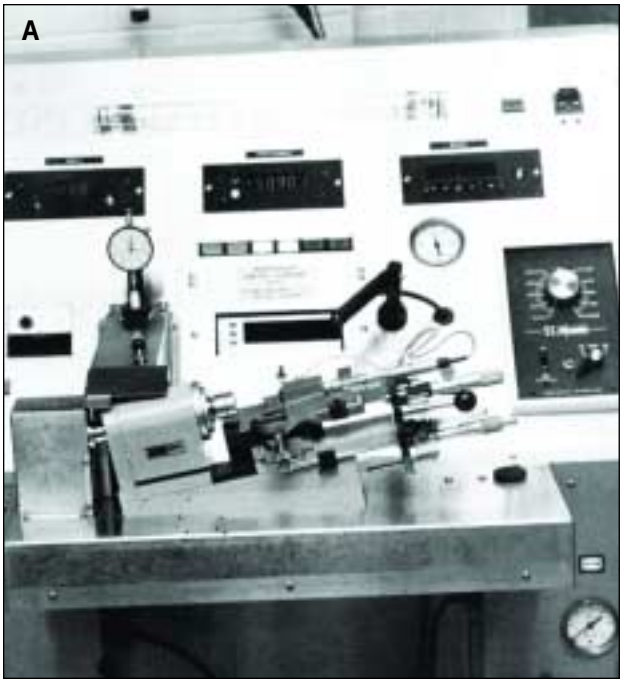
Drs. Barraquer and Troutman met initially in Tubingen, Germany, in August 1966 at the First Biennial International Ophthalmic Microsurgery Study Group, which Dr. Troutman had organized along with Heinrich Harms, MD, and Günter Mackensen, MD. These early pioneers of microsurgery promoted an international dialogue on new developments in technique and instrumentation for ophthalmic microsurgery, which was practiced by a small minority of ophthalmologists worldwide at the time. Dr. Barraquer was among the 30 early advocates who attended. Only seven participants were from North America.

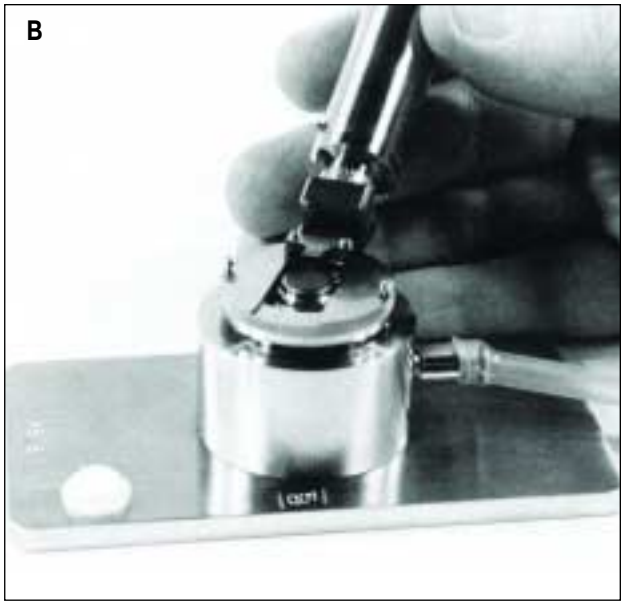
At the meeting, Drs. Barraquer and Troutman began an ongoing dialogue on their investigative interests in corneal refractive surgery. Dr. Barraquer's long-term research focused on the surgical correction (which he termed *keratomileusis*) of myopic and low-hyperopic ametropia and a more recent procedure (known as *keratophakia*) that he was developing specifically for correcting aphakic ametropia. Dr. Troutman's primary interests were the prevention and correction of astigmatism, especially from the cataract incision, as well as from penetrating keratoplasty (by means of his Corneal Wedge Resection and Corneal Relaxing Incisions procedures).

Although fascinated by the possibilities of keratomileusis, Dr. Troutman was more interested in the immediate potential of keratophakia as an alternative to IOLs for the correction of aphakia, because the IOL implants in use at that time were causing serious complications. A decade would pass before Dr. Barraquer was ready to present these two procedures and recommend them for use.

(Courtesy of Richard Keeler.)

The Third Meeting of the Ophthalmic Microsurgery Study Group, organized by Dr. Troutman, was held in Merida, Yucatan, in March 1970. Dr. Barraquer is pictured ascending a nearby pyramid.





The authors used both the Barraquer cryolathe (A) and the Barraquer-Krumeich-Swinger nonfreeze refractive set (B).

BARRAQUER'S COURSE IN REFRACTIVE SURGERY

In May 1976, Dr. Barraquer presented his results on keratomileusis and keratophakia at the First International Corneal Congress in Washington. He informed Dr. Troutman that he was ready to teach the technique and invited Dr. Troutman to participate in his first course in Bogotá, Colombia, in July 1977. Dr. Troutman immediately ordered a microkeratome (used to remove the anterior portion of the cornea) and a cryolathe (the instrument used to freeze and optically reshape the corneal tissue).

On July 1, 1977, Dr. Swinger (who had trained at Manhattan Eye, Ear and Throat Hospital) became Dr. Troutman's fellow in corneal and refractive surgery. A few days later, they both left for Bogotá. An unusual synchronicity united them with Dr. Barraquer. The course took place over an intense 5 days and consisted of many hours of lectures, laboratory work, live surgery, and discussions.

It was immediately evident that both keratophakia and keratomileusis were demanding surgical techniques that would require meticulous evaluation and technical simplification to be generalized. Dr. Troutman had to return to the US, but he arranged with Dr. Barraquer for Dr. Swinger to stay for another 4 weeks to observe him and plan for the North American clinical trial and investigation. Even before Dr. Swinger left Bogotá, he had envisioned a simpler procedure that could be performed without freezing, a cryolathe, or a computer, thereby avoiding cellular damage and speeding visual recovery. This modification required 7 more years to develop and introduce.

FIRST SURGERIES AND CLINICAL TRIALS

In 1977, the US investigation of keratophakia began. The rigorous mathematical foundation and engineering aspects of the procedure demanded computer literacy, and the more than 100 steps of the surgical procedure made enormous technical demands as well. Fortunately, Dr. Swinger had been an aerospace engineer, and Dr. Troutman was a pioneer in corneal surgery.

On October 7, 1977, they performed a keratophakia procedure (the first refractive surgery for the correction of ametropia to take place in North America) and began a prospective clinical trial. They presented their results to the American Academy of Ophthalmology and Otolaryngology in October 1978. Although the first cases were surgically successful, the unique nature, technical difficulty, and variable optical outcomes of the procedure meant that its future remained uncertain.

After completing his fellowship in June 1978, Dr. Swinger became the first ophthalmologist in the US to limit his practice to refractive surgery. In December 1978, he and Dr. Troutman organized the first course on keratophakia and keratomileusis, held in New York, with Dr. Barraquer serving on the faculty. Six surgeons attended. These courses were held regularly and trained more than 100 surgeons, and Dr. Barraquer continued

to train additional surgeons in Bogotá.

Also in 1978, Dr. Swinger performed his first cases of myopic keratomileusis (MKM) in Europe. The following year, he began a prospective study on MKM in the US, during which he performed the first refractive surgery for the correction of congenital ametropia. Until that time, his and Dr. Troutman's refractive surgery had been limited to hyperopic keratomileusis and keratophakia.

FOUNDING THE INTERNATIONAL SOCIETY FOR REFRACTIVE KERATOPLASTY

During the 1979 New Orleans Academy of Ophthalmology meeting, where Drs. Barraquer, Troutman, and Swinger lectured on refractive surgery, Drs. Troutman and Swinger convinced Dr. Barraquer to join them in forming an international society devoted to the orderly scientific evaluation and dissemination of refractive keratoplasty principles and techniques. With Miles Friedlander, MD, they founded the International Society for Refractive Keratoplasty, later renamed the International Society for Refractive Surgery (ISRS). The organization continues to sponsor scientific meetings and courses on refractive surgery around the world as well as the *Journal of Refractive Surgery*, first in its field. In 1981, the AAO invited the ISRS to organize an annual symposium on refractive surgery, the first international organization to be so invited. In May 2003, with the establishment of the ISRS/AAO, this symposium became the AAO's official forum for refractive surgery.

EPILOGUE

Around 1980, RK for myopia and epikeratophakia, which had been developed to simplify keratophakia and keratomileusis, were proposed. Drs. Troutman and Swinger's experience and understanding of corneal physiology and mechanics demonstrated to them that epikeratophakia was inferior anatomically and functionally to MKM. The procedure was soon discontinued. Designed as a substitute for intracapsular cataract extraction with IOL implantation, keratophakia became obsolete with the success of posterior chamber IOLs placed inside the capsular bag after extracapsular cataract extraction or phacoemulsification.

In 1985, the excimer laser was proposed for refractive keratoplasty. The nonfreeze procedures, MKM and anterior lamellar keratoplasty, had dramatically simplified Barraquer's keratomileusis and led to its adoption by a small but devoted group of surgeons, although accuracy remained problematic. Eliminating the freezing cycle proved to be the key to immediate anatomic and functional recovery, but postoperative corneal irregular astigmatism still limited the quality of the results. Interest in the Barraquer-inspired procedure quickly gave way to the more precise, if more complex and costlier, laser technology when it became available in the early 1990s.

Although the use of RK persisted until the early 1990s, the procedure proved to be less than ideal, especially because of its instability for higher corrections. Dr. Swinger and Richard Villasenor, MD, developed homoplastic MKM to correct very high myopia, but the results were not highly reproducible. By 1990, the laser procedures proved to be simpler technically, and they delivered a level of accuracy and reproducibility not possible with traditional keratomileusis. The demise of RK was imminent. After trying PRK, Drs. Troutman and Swinger transitioned to LASIK, which preserved Bowman's layer (Dr. Barraquer's original principle) and yielded superior optical results and faster anatomical and visual recovery.

Introducing Dr. Barraquer's concepts to the US was not simply a historic event. Many in the profession argued strongly against operating on a normal cornea with the intent of correcting an axial refractive error, and the technical difficulty of the procedure did nothing to increase its popularity. For a decade or more, only a few individuals continued to intensively propagate the procedure's potential benefits despite many challenges. Finally, new technology enabled ophthalmologists to meet the surgical demands and eliminate the inaccuracies inherent to the original procedures. Dr. Barraquer's keratomileusis in its present form, LASIK, has become one of the most commonly performed ophthalmic surgical procedures in the world. ■

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