

## RADIAL KERATOTOMY

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I was scheduled to speak to you today on the Artificial Anterior Chamber that is currently being used for Keratophakia. And with your permission, I wish to talk instead on the topic of Radial Keratotomy. Radial Keratotomy has been causing a great deal of interest in the last few months in the United States, and has prompted our research groups at U.S.C. and U.C.L.A. to begin animal and human investigation. I will discuss some of our preliminary work, share with you some of our enthusiasm, and hopefully, make you aware of some of the complications that we might see in the future.

### *SLIDE OF HISTORY OF MYOPIC SURGERY*

Doctors have been interested in correcting myopia for many years. Probably the best documented paper was by Fukala in 1889 in which a series of high myopes were operated on for removal of the clear crystalline lens. The complication rate was extremely high with a large number of retinal detachments, and subsequent blind eyes. Strampelli in 1954 attempted the insertion of an acrylic lens into the anterior chamber. This resulted in late reactions and in damage of the transparent lens of the eye. Drs. Frey, Yamamori and Barraquer-Moner attempted to reduce the axial length of the eye by scleral resection, but this surgery was difficult, and did not give permanent results. Sato in 1953 reported on corneal incisions made with a special knife designed by him. The knife entered the anterior chamber and radial incisions were made similar to the incisions suggested currently. Some incisions were also made on the epithelium side to correct any residual astigmatism, or to supplement the correction of myopia. En-

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tering the anterior chamber produced serious complications in some cases, however, many of his patients obtained good results.

Barraquer in 1964 reported on his results of keratomileusis for the correction of myopia, and he is continuing to do this surgery with good results in cases of 8 diopters or less. Greater than 8 diopters frequently produced some loss of correction. I am presently doing myopic keratomileusis on monkeys, and will report my results at the Academy of Ophthalmology this year. Fyodorov reported his results of the radial keratotomies in Moscow in 1977, and in the december issue of the ANNALS OF OPHTHALMOLOGY presents additional data. He indicates a visual result of 83.7% of the patients with 20/20 to 20/30 vision. Five per cent were 20/50 to 20/60, and 2% were 20/200 without glasses. In some patients there is a 25 reduction of the myopic correction in the first few weeks.

Stabilization of the myopia occurs within three months, and he has noted no deterioration after three months. He reports a complication rate of 7%, and these were limited to early cases in which corneal perforation occurred with no longterm, adverse effect. His results have not been verified by other ophthalmologists, as yet. Dr. Bores, from Detroit, Michigan, became the blade breaker. An alternative is to place the razor blade fragment into the grooves that are placed on the edge of the stainless steel block, and similarly to grasp it with a razor blade breaker. The advantage to this is that the tip of the blade touches the stainless steel, and can dull the tip. Teflon coating may eliminate this. These blades have been specially made for me by Medical Work Shops, and have a present depth and are very sharp. The standard super blade comes in either a 15, 30 or 45 degree angle, and the 15 degree blade is sharper for this procedure. In spite of the sharpness of the super blades, we find that the blade is significantly dull after the initial 8 cuts, and even though the remaining 8 cuts can be made with the same blade, it is easier to use a second matching blade. Fixation at the present time is done with Castroviejo forceps, although Dr. Galan's suction ophthalmodynamometer maintains higher pressure in the eye with good fixation, and may be a better device. Antibiotic and pupillary dilatation is carried out followed by a patch. The majority of the epithelium healing is noted within the first 24 hours with complete healing within the first three days. Immediately following the last incision, one notices a change in the keratometer readings by as much as 6 diopters. I wish to repeat that this is immediately following the last incision. Some of this is lost in the first few days, and with the initial stabilization in one month. This monkey shows what the eye looks like

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two months postoperative. We have achieved a 4 diopter change in this particular animal with a minimum amount of astigmatism. The variables of the surgery include the size of the central optic axis that is spared, the depth of the incisions, and the length of the incisions. These variables are being studied presently by our group.

### --SLIDE-- *ADVANTAGES*

1) The optic axis is spared in Radial Keratotomies as opposed to the Barraquer technique where a lamellar section is removed, frozen, and cut. There is no interface scarring, and no foreign bodies. 2) The equipment is inexpensive. The superblades or whatever blade that ultimately becomes the best blade will be quite inexpensive. The ancillary equipment, such as the pachymeter or endothelial camera and A-scan for axial length are expensive instruments, but can be done in a central laboratory or a University prior to the surgery. 3) It is technically easy; the surgery takes no longer than 10 minutes, and a competent surgeon familiar with microscopic techniques can learn the technique on a one-day symposium. 4) The surgery may be repeated if the desired effect is lost. 5) The visual acuity is relatively rapid. Many cases have noted improvement in their vision within the first ten days.

### DISADVANTAGES

1) The principle objection that I have to the surgery being done in humans at the present time is that there is no long term follow-up. We must realize that 1500 cases have been done in the world, and these include the majority of the cases done by Fyodorov. What the complications will be longterm is impossible to say, since the surgery must be classified as experimental at this time. 2) The surgery is definitely exploitable. What I mean by this is that patients are very eager to undergo the surgery if it is meant to sound like it is an alternative to glasses or contact lenses. I think it is the responsibility of physicians to discourage any patient that is wearing glasses or contact lenses successfully from undergoing this surgery. This criterion may change after several thousand cases have been done, and sufficient follow-up has been obtained. There are certain people, such as law enforcement officers, athletes and others with vocational reasons that would be good candidates for this surgery. Surgery for its cosmetic effect alone should not be done initially.

*THE COMPLICATIONS:*

This is a photograph of one of the patients that we have seen at U.S.C. that was done by Bores and his group. The one eye is approximately one month postop, and the second slide shows higher magnification, and with subsequent integrity of the cell wall. What the longterm effects was only 7 days postop. One can see significant swelling of the stroma and the patient's visual acuity was reduced to 20/200. The left eye that was one month postop had lost much of the effect, but the patient was very happy with 20/50 uncorrected vision. He did, however, complain of glare, but stated that it was a small price to pay for not wearing glasses. The loss of the effect has been mentioned with approximately 25% of the effect lost within the first month, and stabilization with three months.

This series of photographs are of the endothelium of an owl monkey. The first is the preop photo showing a normal, regular pattern. The second is two weeks postop, and the last is one month postoperative. One can see the swelling of the endothelial cells, and the loss of the regular pattern in the first two weeks. By the fourth week, the cells appear to be of normal size, and the pattern has returned to an almost normal state. We have later photographs where the cornea appears entirely normal. It does not appear that these cells are lost with subsequent sliding of cells from the periphery to fill the defect, but rather there is edema will be on the endothelium is one of the major questions.

This next SLIDE is of the incision through the trabeculum. As we continue our incision past the limbus, the deeper cuts will undoubtedly traumatize some of the trabecular tissue. The pressure is initially very soft at the time of the surgery, but returns to normal within 24 hours, and has remained normal for up to two months without a pressure rise. The question of longterm glaucoma is a serious question.

NEXT-Anterior chamber penetration and endophthalmitis is probably our most dreaded complication. Fyodorov reported anterior chamber penetrations and we have had similar experiences. Anterior synechiae did not form, and endophthalmitis did not occur, however, the possibility exists. Vascularization is a theoretical consideration that has not been observed. Induced astigmatism is a reality and incisions free-hand certainly can produce irregular astigmatism. I would like to show you this slide again from one of the patients we saw, and note how the incisions are not made regularly.

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Physicians in the United States are beginning this surgery with what I believe to be a lack of background as to the animal investigation, and as to the knowledge of the technique. In spite of this, I am sure that the next few months will see a large number of ophthalmologists attempting this technique. I suggest that the study be based at the University, or Universities closest to your practice. The surgery need not be done directly in the University, but the physician should be trained by the Universities and given a national standard protocol to follow. If each case has a protocol followed much like the present intraocular lens protocol, then scientific information can be obtained rapidly. If, on the other hand, the physicians do the surgery without a protocol, then it will take us years to uncover the actual results of this surgery. A moratorium should be considered after a sufficient number of cases have been done. This probably is impractical, since there will be ophthalmologists doing this outside of the auspices of the Universities, and if the surgery appears to be safe and effective, we will not want to refrain from doing the surgery for a period of time while others in our community continue doing the surgery. Finally, a central area of data banking should be implemented.

In conclusion, we are entering a decade of refractive surgery of the eye. Dr. Barraquer has seen the tremendous interest in the United States growing in his technique, and one course has already been given in the United States. Fyodorov's technique makes the surgery inviting to the general ophthalmologist, and hopefully, will offer a viable alternative to those specific individuals in whom this surgery is indicated. In addition, the refractive keratoplasty technique of Dr. Barraquer, and the radial keratotomies of Fyodorov have opened the door to research that in the future may eliminate the need for glasses for many nearsighted people.