The 4-Cut Radial Keratotomy in Low Myopia

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ABSTRACT: An analysis of 86 patients undergoing 4-cut radial keratotomy surgery between July 1981 and March 1985 is presented. Ninety-three percent of those followed 12 months after surgery were seeing 20/20 and 100% of those followed up to 3½ years postoperatively were seeing 20/20 without correction. Ninety-four percent of these patients were wearing no glasses or contact lenses at all for distance after this surgery.

Since July 1980, I have been doing radial keratotomy (RK) surgery in my private practice of medicine. In persons with very low degrees of myopia it became apparent that eight incisions were not necessary, and that four incisions could adequately correct their myopia. Previous research with varying numbers of incisions in human cadaver eyes and in owl and stump tail monkeys showed that approximately 60% of the total result obtainable in a 16-cut RK was obtained in the first four cuts. The next four cuts increased the result by 30%, and the last eight cuts added only 10%.1-3

This is a presentation of the results of the first 86, 4-cut RKs performed in my practice between July 1981 and March 1985.

Material and Methods

Eighty-six patients who had 4-cut RK surgery for low myopia were evaluated.

A preoperative analysis of the patients reveals the patients’ mean age to be 35 years (Figure 1). The mean uncorrected preoperative visual acuity was 20/56 with a range from 20/25 to 20/200. The mean preoperative refractive error was –1.06 with a range from –0.75 to 2.87. Preoperative pachymetry had a mean of .52. The mean preoperative keratometry reading (K) was 43.75 and preoperative cylinder was .534.

Preoperative Preparation

The optical zone (OZ) was calculated for each patient as follows:

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<tr>
<th>Keratometry</th>
<th>OZ</th>
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<tbody>
<tr>
<td>42.12 or less</td>
<td>4.0 mm</td>
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<tr>
<td>42.45-44.00</td>
<td>4.25 mm</td>
</tr>
<tr>
<td>44.25-46.00</td>
<td>4.50 mm</td>
</tr>
<tr>
<td>46.12 or less</td>
<td>4.75 mm</td>
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This was used as a base line for calculating the OZ, varying it 0.25 mm smaller for younger patients and 0.25 mm larger for patients 40 years of age and older. A larger OZ was used for older males than for older females. The average OZs actually chosen for these 86 patients are reflected in Table 1.

Patients were given gentamicin sulfate (Genoptic®) or A.K. Chlor drops to use every 10 minutes for 45 minutes before surgery. Tetracaine 0.5% drops were then used every 5 minutes for 15 minutes before surgery.

Patients were then gowned, hats were put over their hair, shoes were removed, and they were brought into a surgery suite of an outpatient surgery facility. The area around the eye was prepared with a povidone-iodine (Betadine®) solution and a sterile plastic adhesive drape was applied. An operating microscope was used on all cases.

Operative Procedure

The optical zone marker was first checked to be sure it was the correct size pre-determined for each case. One or two drops of 4% cocaine were then inserted for final anesthesia. The Storz diamond blade was then set .06mm to .08mm deeper than the thinnest central pachymetry reading. A wire lid speculum was then inserted. The patient was asked to look at the light in the microscope, which had been dimmed with a rheostat. The optical zone marker was then centered around the light reflex on the cornea and an indentation was made with light pressure.

The Bracken-Farcus forceps were used to grasp the 3 o’clock peripheral cornea, fixating the globe. The point of the diamond knife was pressed into the cornea to its full depth at the 9 o’clock position on the optical zone mark. The incision was carried outward, stopping just short of the limbus. The Bracken-Farcus forceps were
then used to grasp the edge of the 9 o'clock cut while the 3 o'clock incision was being made. Care was taken to insert the diamond to its full depth before an outward movement was begun. The 6 o'clock cornea was grasped in the periphery with Bracken-Farceps while the 12 o'clock cut was made, and then a 0.12 mm forceps was used to grasp the edge of the 12 o'clock cut fixing the globe while the 6 o'clock cut was being made.

All four incisions were then irrigated carefully with balanced salt solution. Antibiotic drops were applied and the patient's eye was patched shut.

The technique varied little from that used by other surgeons except that only four incisions were made and larger optical zones were utilized.

**Postoperative Care**

Patients were given a prescription for pain medication, which was taken by mouth as needed.

On the first postoperative day the patch was removed, the uncorrected vision was checked, the patient was auto-refracted, and a slit-lamp examination was done. Assuming no complications were noted, the patients were told to use gentamicin sulfate (Genoptic<sup>®</sup>) drops i.t.d. and Poly Pred<sup>®</sup> b.i.d. Routine follow-up exams are scheduled for 1 week, 1, 3, 6, and 12 months, and yearly thereafter.

The second eye was usually operated on 1 month after the first eye.

**Results**

The uncorrected visual acuity at 6 and 12 months is shown in Figures 2 and 3, respectively. Visual acuity 2 and 3.5 years postoperatively where 100% of the patients were seeing 20/20 is shown in Figure 4.

As shown in Table 2, 87.2% of the patients had a postoperative refraction within 0.50 diopter (D) of emmetropia and 100% were within 1.0 D of emmetropia 6 months postoperatively. By 2 years postoperatively, 100% fell within 0.50 D of emmetropia. No shift toward myopia or hyperopia is shown in these patients once a final stabilization occurs, which is 3 to 6 months postoperatively. The mean decrease in dioptries at 3 months is 1.15, at 6 months is 1.20, and at 12 months is 1.21, which shows very little change in refraction between 3 and 12 months. The decrease in average K at 3 months was 1.22 and at 6 months was 1.26, showing that the average K changed only 0.04 D between 3 and 6 months.

The mean cylinder 3 months postoperatively was 0.52 D, which changed very little 6 months postoperatively (0.48 D). The change in postoperative cylinders compared to the preoperative cylinders is shown in Figures 5 and 6. This reveals essentially no change in the cylinder with these 4-cut RKs (-0.007 D of change at 6 months).

Glasses were totally eliminated in 94% of the patients 6 months postoperatively. Six percent (three patients) wore glasses part of the time, and no one wore them full time.

**Complications**

One microperforation occurred on the second person in the study. There were none on the 84 that followed. There were no macroperforations and no need for sutures. No cases were terminated before completion.

The one patient with 20/40 continued on page 168
FML Forte® (fluorometholone) 0.25%
Liquiform® sterile ophthalmic suspension

INDICATIONS AND USAGE: FML Forte is indicated for the treatment of corticosteroid-responsive inflammation of the palpebral and bulbar conjunctiva, cornea and anterior segment of the globe. CONTRAINDICATIONS: - Epithelial herpes simplex keratitis (dendritic keratitis), vaccinia, varicella, and other viral diseases of the cornea and conjunctiva - Tuberculosis of the eye - Fungal diseases of the ocular structures - Hypersensitivity to any component of the medication

WARNINGS: Corticosteroid medication in the treatment of herpes simplex keratitis (involving the stroma) requires great caution; frequent slit-lamp microscopy is mandatory. Prolonged use may result in glaucoma, with damage to the optic nerve, defects in visual acuity and fields of vision, or in posterior subcapsular cataract formation, or may aid in the establishment of secondary ocular infections from fungi or viruses liberated from ocular tissues. In those diseases causing thinning of the cornea or sclera, perforations have been known to occur with the use of topical corticosteroids. Acute purulent untreated infection of the eye may be masked or activity enhanced by presence of corticosteroid medication.

PRECAUTIONS: General: As fungal infections of the cornea are particularly prone to develop coincidentally with long-term topical corticosteroid applications, fungal invasion must be suspected in any persistent corneal ulceration where a corticosteroid has been used or is in use. As with other corticosteroids, frequent intraocular pressure checks are warranted since a significant increase in IOP may occur in a small percentage of patients treated with FML Forte. Carcinogenesis, mutagenesis, impairment of fertility: No studies have been conducted in animals or in humans to evaluate the possibility of these effects with fluorometholone. Pregnancy Category C: Fluorometholone has been shown to be teratogenic and embryocidal in rabbits when given in doses approximating the human dose and above. There are no adequate well-controlled studies in pregnant women. Fluorometholone should be used during pregnancy only if the potential benefit outweighs the potential risk to the fetus. Fluorometholone was ocularly applied to both eyes of pregnant rabbits at various dosage levels on days 6 to 16 of gestation. A significant dose-related increase in fetal abnormalities and in fetal loss was observed. Pediatric Use: Safety and effectiveness in children have not been established. ADVERSE REACTIONS: Adverse reactions include, in decreasing order of frequency, elevation of intraocular pressure (IOP) with possible development of glaucoma and infrequent optic nerve damage; loss of visual acuity or defects in fields of vision; posterior subcapsular cataract formation; delayed wound healing; and conjunctival erythema. The following have also been reported after the use of topical corticosteroids. Secondary ocular infection from pathogens liberated from ocular tissues and, rarely, perforation of the globe when used in conditions where there is thinning of the cornea or sclera.

Figure 2. Uncorrected visual acuity 6 months postoperative; N = 50.

Figure 3. Uncorrected visual acuity 12 months postoperative; N = 29; 3.5% reflects one patient.

Figure 4. Visual acuity 2 to 3½ years postoperative; N = 10.
vision 12 months postoperatively (Figure 3) had a second set of four incisions done, with a subsequent visual acuity of 20/20.

Subjective glare and variability in vision cleared rapidly in these patients and neither was a problem beyond 3 months postoperatively. No infections, recurrent erosions, or vascular ingrowth of incisions was noted. No patient had a loss in best-corrected visual acuity after surgery.

Discussion

The vast majority of these patients came to me requesting the surgery. They usually had friends or relatives who had already had successful RK surgery, and they, too, wanted to be able to go without glasses or contact lenses. If they were of a presbyopic age, much care was taken to explain to them that if we got rid of the myopia, they would be forced into wearing reading glasses. With this knowledge, some people no longer wanted surgery. Others still wanted it, saying they would rather wear glasses for near than for distance. Still others elected the option of operating on only one eye and leaving their other eye myopic for close work.

The 4-cut RK has been a very valuable tool for use with patients with low myopia. The larger optical zones and fewer incisions make recovery very rapid and complications very few.

As long as care is taken to make the four incisions evenly spaced and at an even depth, astigmatism is neither created nor changed to any significant degree. Accuracy with this surgery seems good, with 87.2% of the patients within 0.5 D of emmetropia 6 months postoperatively and 100%, 2 years postoperatively.

Patient satisfaction is very high, since 100% of these patients were wearing glasses or contact lenses for distance before surgery, and

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<tr>
<th>Post</th>
<th>−0.50 to +0.50</th>
<th>−1.00 to +1.00</th>
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<tr>
<td>6 months</td>
<td>87.2%</td>
<td>100%</td>
</tr>
<tr>
<td>1 year</td>
<td>85.7%</td>
<td>97.2%*</td>
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<tr>
<td>2 years</td>
<td>100%</td>
<td>100%</td>
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*One patient (2.9%) was +1.2 to +1.50

References