Homoplastik Keratomileusis for the Correction of Myopia

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ABSTRACT: The authors performed primary homoplastic myopic keratomileusis (MKM) on ten eyes with a minimal followup of three months. The mean preoperative refractive error was −15.13 diopters. Postoperatively, the mean myopia was −0.89 diopter. The surgical accuracy was 93% ± 8.6% with a correlation coefficient of 0.98. Refractive astigmatism was reduced by 0.52 diopter. All patients achieved their preoperative spectacle acuity except for one patient whose vision was reduced from 20/20 to 20/25. The authors conclude that primary homoplastic MKM warrants further investigation as an alternative to autoplastic MKM and myopic epikeratophakia.

José Barraquer initially introduced myopic keratomileusis (MKM) as a homoplastic procedure.1,2 His first clinical results with this technique were reported in 1961, for four cases. Because of a severe limitation of donor material, Barraquer has emphasized the autoplastic forms of both myopic and hyperopic keratomileusis.

Although autoplastic MKM has been performed for over 20 years, few clinical reports exist in the literature.3-11 Nevertheless, this surgical procedure appears to provide satisfactory results. Major disadvantages, however, are technical complexity and surgical difficulty. Several hundred surgeons have been trained in this surgery, yet a very small number perform it on a regular basis. It certainly can be mastered if one devotes the time and energy to it, but it becomes difficult when performed sporadically.

Impressed by our early results with homoplastic MKM following undercorrected radial keratotomy, we elected to attempt primary homoplastic MKM as an alternative to autoplastic surgery.12 The concepts and initial clinical results of our prospective series are presented in this report.

Materials and Methods

We have initiated a prospective evaluation of primary homoplastic MKM. All surgery is performed by the authors. All patients are 18 years of age or older, unsatisfied with their present modality of optical correction, and all have attempted contact lens wear. Patients must have at least 5 diopters of myopia to enter the study. All preoperative and postoperative evaluations are carried out by independent observers and consist of a complete ophthalmologic examination, keratometry, corneoscopy, ultrasonic pachymetry, and specular microscopy, when indicated.

This report consists of ten patients, five males and five females, with a mean age of 33 years. The mean followup was 10.2 months with a range of three to 36 months. The mean preoperative keratometry was 44.3 diopters ± 2.8 diopters. The mean keratometric astigmatism was 1.78 diopters, and, when based on refraction, the mean cylinder was 1.80 diopters. Details, including refractions, are provided in Table 1.

The donor tissue used for preparing the homoplastic lenticules was unsuitable for penetrating keratoplasty. In all instances, either fresh globes or corneas preserved in McCarey-Kaufman solution were used. At the time of use, all donor tissue was less than six days old. A lamellar keratectomy was performed on the donor tissue with the Barraquer microkeratome, after having first removed the epithelium. The thickness of the keratectomized disc and the thickness of the donor cornea were entered into a modified homoplastic MKM program that we are developing. Following their production on the Barraquer cryolathe in the classic fashion, lenticules were stored in the frozen state for up to 96 hours prior to use. At the time of use, they were rapidly thawed with filtered normal saline and placed onto the keratectomized cornea of the patient. Lenticules were centered over the visual axis as best as possible and fixated with either a

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TABLE 1
Detailed Results of Ten Patients Who Underwent Primary Homoplastic MKM

<table>
<thead>
<tr>
<th>Patient</th>
<th>Followup</th>
<th>Preop Refraction</th>
<th>Postop Refraction</th>
<th>Spectacle Acuity</th>
<th>Preop</th>
<th>Postop</th>
<th>Uncorrected Postop Acuity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>36 Mo</td>
<td>16.00 - 3.50 x 03</td>
<td>-25 - 0.75 x 150</td>
<td>20/70</td>
<td>20/70</td>
<td>20/70</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>24 Mo</td>
<td>-9.75 - 1.00 x 51</td>
<td>-0.25 - 2.00 x 20</td>
<td>20/20</td>
<td>20/25</td>
<td>20/50</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>15 Mo</td>
<td>-12.75 - 1.00 x 15</td>
<td>+2.75 - 3.00 x 80</td>
<td>20/100</td>
<td>20/70</td>
<td>20/100</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>12 Mo</td>
<td>-14.25 - 2.75 x 90</td>
<td>-2.50 Sph</td>
<td>20/100</td>
<td>20/40</td>
<td>20/100</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>6 Mo</td>
<td>-12.50 - 2.50 x 180</td>
<td>-200 - 1.50 x 150</td>
<td>20/40</td>
<td>20/40</td>
<td>20/70</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>3 Mo</td>
<td>-16.25 - 2.75 x 30</td>
<td>plano</td>
<td>20/200</td>
<td>20/25</td>
<td>20/25</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>3 Mo</td>
<td>-9.00 Sph</td>
<td>-0.25 - 2.00 x 70</td>
<td>20/70</td>
<td>20/100</td>
<td>20/70</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>3 Mo</td>
<td>-24.00 - 3.00 x 55</td>
<td>+0.50 - 3.00 x 70</td>
<td>20/400</td>
<td>20/300</td>
<td>20/300</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>3 Mo</td>
<td>-14.25 - 1.50 x 35</td>
<td>plano</td>
<td>20/40</td>
<td>20/30</td>
<td>20/30</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>3 Mo</td>
<td>-15.00 Sph</td>
<td>-0.50 - 0.50 x 150</td>
<td>20/40</td>
<td>20/40</td>
<td>20/40</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 2
Refractive Correction Following Primary Homoplastic MKM (N = 10)

<table>
<thead>
<tr>
<th>Refractive Error</th>
<th>Postop</th>
<th>Preop</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.89 D (Plano to -2.75)</td>
<td>-15.13 D (-8.25 to -25.5)</td>
</tr>
<tr>
<td></td>
<td>14.24 D ± 4.85 D</td>
<td></td>
</tr>
</tbody>
</table>

single 8-bite, anti-torque suture or a running suture, both of 10-0 nylon. Patients were kept patched until the epithelium had healed. Prednisolone acetate, 1% drops, and garamycin drops were prescribed b.i.d. until the epithelial defect had healed, at which time medications were increased to q.i.d. for approximately one month. Sutures were removed at two or three weeks following surgery.

Results
Table 2 provides the refractive correction obtained in this series of ten patients. As can be seen, the mean correction (14.24 diopters) was well beyond means published for autoplasic MKM. The maximal correction was 24.5 diopters.

The surgical accuracy was calculated by dividing the mean refractive correction obtained by the mean refractive correction desired, based on refraction only. This gave a mean percentage correction of 93% ± 8.6% with a range of 80.0% to 109%. Figure 1 demonstrates the scattergram of the correction obtained when plotted versus the correction desired. The correlation coefficient for this plot is r = 0.98.

When calculated on the basis of refraction, astigmatism decreased from a mean of 1.80 diopters to a mean of 1.28 diopters, a reduction of 0.52 diopter. The maximal increase in any patient was 2 diopters and the maximal decrease in any patient was 2.75 diopters.

Figure 2 provides a scattergram plot of the best-corrected preoperative spectacle acuity versus the best-corrected postoperative spectacle acuity. These data are also provided in Table 1. The scattergram demonstrates that all patients but one returned to their preoperative spectacle acuity, with several patients demonstrating marked improvement, in one case from 20/200 to 20/25 three months following surgery.

One complication was encountered in this series, that of a persistent epithelial defect in patient No. 10. The patient was successfully re-grafted with a second homoplastic lenticule at ten days following the initial procedure.

Discussion
Although the number of cases in this initial series is small, a number of observations concerning homoplastic MKM may be made to allow for a discussion of its advantages and disadvantages. A major advantage is that MKM can be markedly simplified by using precarved lenticules. Both the cryolathe and the calculator are eliminated from the operating room, thereby decreasing markedly the stress of the surgical procedure.

In this series, we had a maximal correction of 24.5 diopters, far beyond that previously obtainable with autoplasic MKM. Because homoplastic MKM derives a lenticule from the total thickness of a donor, corrections at least as great as those obtainable with myopic epikeratophakia can be achieved. This greatly extends the upper range of patients previously correctable with MKM.

Most patients who undergo refractive corneal surgery for myopia desire an improvement in either their uncorrected or their best-corrected vision, or both. This necessitates that the surgical procedure be both accurate and not
detrimental to the visual acuity. In this series, we obtained a surgical accuracy exceeding that of any previously reported series for any refractive surgical technique. It must be re-emphasized, however, that there were only a small number of patients in this series. Nevertheless, the authors have previously not experienced comparable accuracy with any other refractive surgical procedure. The correlation coefficient was 0.98 and the standard deviation at a low 8.6%.

One reason for the increased accuracy may be that in homoplastik MKM one performs a lamellar keratectomy greater in diameter than that of the lenticule to be used. Thus, the edge of the lenticule does not abut the peripheral cornea at any point. This decreases any lateral stress or induced tension, such as may exist with autoplastik MKM or myopic epikeratophakia. In both autoplastik MKM and myopic epikeratophakia, there is contact and interaction between the peripheral edge of the lenticule and the peripheral aspect of the keratectomy.

In addition, the cornea may be left at a relatively constant final thickness following homoplastik MKM, whereas the corneal thickness varies significantly following autoplastik MKM, depending on the refractive correction obtained. This latter characteristic, in combination with varying intraocular pressure, may be responsible for some of the variability in results obtained with autoplastik MKM. Homoplastik MKM, however, can limit this variability by providing a constant final corneal thickness for all patients.

A major concern with all refractive surgical techniques is their effect on visual acuity. Our series demonstrates once again that lamellar refractive surgery for myopia is capable of improving the best-corrected spectacle acuity of a patient. In our series, one patient experienced a dramatic improvement from 20/200 to 20/25. At the present time, we are unable to predict which patients will experience such marked improvement, but studies are in progress. It is important to note that no patient experienced a reduction in their vision of greater than one line.

One patient suffered a loss of spectacle acuity of 20/20 to 20/25.

It is possible that the visual results obtained with homoplastik MKM may conceivably be as good, if not better, than those obtainable with autoplastik MKM for the following reasons. First, the keratectomy is a critical part of any keratomileusis procedure. In autoplastik surgery, if the keratectomy is decentered off the visual axis, the surgeon has no recourse but to abort the procedure or to allow a minor decenteration of the optic zone with respect to the visual axis. However, because the pre-carved lenticule in homoplastik MKM is significantly smaller in diameter than the bed, the pre-carved lenticule may be decentered on an already decentered bed to ensure that the optic zone of the lenticule is well centered on the visual axis. This should eliminate both irregular astigmatism and decreased vision because of decentered optic zones.

In addition, the final central thickness of the homoplastik lenticule is significantly thicker, especially for higher corrections, than corresponding autoplastik
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MKM lenticules (Figure 3). This derives from the fact that the total donor cornea is available for producing the lenticule. As the central lenticular thickness increases, the stability of the central aspect of the lenticule increases, thereby reducing the chance of irregular astigmatism. In addition, increased thickness allows for large optic zone diameters, greater than those obtainable with autoplastic MKM, especially for higher corrections.

A major advantage of homoplastic MKM, especially for the beginning surgeon, is that the keratectomy becomes less critical. In autoplastic MKM, after the keratectomy has been made there is no adequate way to ensure that it is of constant thickness throughout. Gross irregularities are readily discernible, but small ones are not. When the surgeon carves the lamellar disc on the Barraquer cryolathe, he has irreversibly produced a spherical lens. If this is replaced on an irregular bed, irregular astigmatism results as the curvature of the bed is transmitted to the anterior surface of the lenticule. Replacement of this lenticule will not correct this condition, but repeat surgery at a later time and possibly a penetrating keratoplasty may be required.

On the other hand, a large safety margin is afforded by homoplastic MKM. After the keratectomy on the patient's eye, the resected tissue, if seemingly adequate, can be placed into intermediate storage media. The precarved lenticule is then placed and sutured. Over the next seven to ten days the cornea may be adequately examined with a slit-lamp and evaluated with corneoscopy. Should irregularities be detected and be attributed to the keratectomy, the lenticule can be removed and the patient's anterior cap replaced, thereby restoring the corneal integrity. The patient's anterior cap is the only tissue capable of restoring a normal corneal contour if an irregular keratectomy was obtained.

Other advantages of homoplastic MKM are that it can be used to correct patients with concomitant pathology (such as anterior membrane dystrophy or anterior scars) and myopia, patients who are undercorrected or overcorrected following previous radial keratotomy or autoplastic MKM, and patients who have thin corneas, where very limited correction is obtainable with autoplastic MKM.

An advantage of homoplastic MKM over myopic epitheliophakia is that the majority of the lenticule lies within the cornea, not atop it, thereby possibly decreasing pressure on the thickened wing and increasing the stability of the refractive result obtained.

Although homoplastic MKM has a great number of potential advantages, there are potential disadvantages. One disadvantage is exhibited by our one complication, where the lenticule did not epithelialize. Autoplastic lenticules typically epithelialize very rapidly, whereas homoplastic lenticules do so more slowly, sometimes requiring five to ten days. However, this is a reversible complication, as a new lens can be placed.

A disadvantage of homoplastic MKM compared to myopic epitheliophakia is that a central keratectomy needs to be performed. Further evaluation of both techniques is necessary to allow for clinical comparisons.

Also of concern is the fact that homoplastic tissue is of inferior quality compared to autoplastic tissue. Donor tissue is metabolically deranged, and the keratocytes are in various stages of degeneration. It is conceivable that visual rehabilitation may be delayed following homoplastic MKM, though we do not have statistics to support this. However, the final visual result may compare quite favorably to autoplastic surgery. In addition, by increasing the central corneal thickness, which has discrete advantages,
the disadvantage of decreased visual rehabilitation, as is seen following hyperopic procedures where the frozen, damaged tissue is of increased thickness, may result. Further studies are required to determine if this is the case. In addition, we are evaluating homoplastic tissue that has been produced without freezing, using a newly developed instrument.13

In conclusion, we have found homoplastic MKM to be a surgical procedure much simpler to perform than autoplastic MKM. It offers the beginning surgeon the opportunity to evaluate keratomileusis without investing time and funds in the cryoablative and calculator. Certainly, all lamellar refractive surgery should be performed with precarved tissue if the final results compare favorably with the results of autoplastic surgery. We continue to evaluate homoplastic MKM to determine its safety, efficacy, and place in our surgical armamentarium.

References