Keratometric Results During the First Year After Keratoplasty: Adjustable Single Running Suture Technique Versus Double Running Suture Technique

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**BACKGROUND AND OBJECTIVE:** To compare the 3-month and 1-year postoperative keratometric results in a retrospective sequential series of corneal grafts performed with either a double running suture technique or an adjustable single running suture technique.

**MATERIALS AND METHODS:** Keratometry values obtained 3 months and 1 year after penetrating keratoplasty, when sutures were still present, were compared between 31 grafts with double running sutures and 27 grafts with single running sutures, 15 of which had been adjusted postoperatively.

**RESULTS:** No significant difference in mean keratometry between the 2 groups was found either 3 months or 12 months after keratoplasty. Mean keratometric astigmatism was significantly less in the single running group at both 3 months (2.2 ± 1.9 vs 4.5 ± 2.8, mean ± SD, P <0.001) and 12 months (3.0 ± 2.2 vs 4.2 ± 2.1, P = 0.03). Within groups, there was no significant change from 3 months to 12 months in either mean keratometry or keratometric astigmatism.

**CONCLUSION:** The single running suture technique, with postoperative adjustments, produced less keratometric astigmatism during the first postoperative year, when sutures were still in place.


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**INTRODUCTION**

After an uncomplicated penetrating keratoplasty in which the graft remains transparent, the corneal surgeon is focused mainly on one important aspect of the visual recovery, the postoperative astigmatism.\(^1\) Irregular or high astigmatism is frequently observed in postkeratoplasty patients and could produce a severe decrease in visual function.\(^2\) This postoperative astigmatism results from several factors: trephination, donor-recipient disparity, recipient pathology, and suture technique.\(^2,3\)

When interrupted sutures are used, either alone or in combination with a running suture, it is possible after adequate wound healing to reduce the astigmatism by removing selected sutures that are producing irregular traction on the wound.\(^3-6\) If a single running suture is used, it is possible to adjust the suture from the flat area of topography toward the steep area, thus steepening the flat meridian and flattening the steep meridian.\(^5,7-11\)

If the double running suture technique with 10-0 and 11-0 nylon is used, however, no adjustment for astigmatism is made.\(^12,13\) The 10-0 nylon suture, which is tighter and potentially causes more astigmatic distortion, is removed at 2 months after keratoplasty, but this does not usually reduce the keratometric...
Table 1. Reasons for Exclusion from the Study

<table>
<thead>
<tr>
<th>Suture Type</th>
<th>Double</th>
<th>Single</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilateral cases (second eye)</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Suture reactions</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Suture replacement required</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>No keratometer readings</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Did not return for examination</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Sutures removed before 1-year examination</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Graft failure</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>17</td>
</tr>
</tbody>
</table>

Table 2. Indications for Penetrating Keratoplasty

<table>
<thead>
<tr>
<th>Suture Type</th>
<th>Double</th>
<th>Single</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuchs’ dystrophy</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>Pseudophakic corneal edema</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Aphakic corneal edema</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Keratoconus</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td>27</td>
</tr>
</tbody>
</table>

astigmatism. In 1995, we changed from the double running suture technique to a single running (adjustable) suture technique for cases in which a running suture was used. The double running technique had been designed originally to provide earlier visual rehabilitation. Therefore, we conducted a retrospective study to determine: 1) if the single running technique with suture adjustment performed 3 to 8 weeks postoperatively resulted in less astigmatism than the double running technique during the first postoperative year, when the sutures remained in place, and 2) if the astigmatism changed from 3 months to 1 year postoperatively.

MATERIALS AND METHODS

We examined the medical records of all patients undergoing penetrating keratoplasty performed entirely (cases performed by fellows were excluded) by one surgeon (WMB) between January 1993 and October 1997 in which a double running or a single running suture technique was used. Of 94 consecutive patients with corneal transplants that met the above criteria, we obtained consent for medical history review for research purposes from 92 patients: 48 with a double running suture technique and 44 subsequent patients with a single running suture technique. If both eyes of the same individual received transplants during the study period, only the first eye was included to avoid erroneous conclusions resulting from inter-eye correlations. Patients were also excluded because of insufficient data or complications that affected corneal curvature. In all, 17 grafts were excluded from each group, leaving 31 in the double running group and 27 in the single running group. Reasons for exclusion of cases from each group are listed in Table 1. Indications for penetrating keratoplasty in each group are listed in Table 2.

In the double running group, 2 running sutures of 12 bites each were placed with 10-0 and 11-0 nylon. The 10-0 suture, which was deeper and tighter, was removed 2 months after keratoplasty and the 11-0 suture was left in place for one year. In the single running group, a 10-0 nylon running suture with 24 bites was used. In both groups, penetrating keratoplasty was done with the Hanna trephine system and suture alignment marks were placed with gentian violet. All donor corneas were stored in Optisol, Optisol-GS, or Chen medium at 4°C. The median trephine size was 7.50 mm for recipient corneas and 7.75 mm for donor corneas in each group.

In the single running group, the suture was adjusted in all cases at the end of the procedure to make the hand-held keratometer ring mires round. Three weeks postoperatively, if 3 or more diopters of keratometric astigmatism were present, the running suture was adjusted again at the slit lamp. Suture adjustment was performed with a dedicated instrument (Serdareshvic suture adjuster, #18901, Microtech, Doylestown, PA). Postoperative corneal topography (TMS-1, Tomey, Inc., Waltham, MA) was measured and used to guide suture adjustment.

Keratometric astigmatism was measured with an optical keratometer (Bausch & Lomb, St. Louis, MO) at 3 months (±1 month) and 12 months (±1 month) after keratoplasty. A Student t-test for means or Wilcoxon rank sum test was used to compare mean keratometry and keratometric astigmatism between the two groups, depending on the distribution of the data. For comparing the change from 3 months to 1 year within groups, we used either paired t-tests or
Table 3. Postoperative Keratometry (mean ± SD)

<table>
<thead>
<tr>
<th>Number</th>
<th>3 Months Suture Type</th>
<th>1 Year Suture Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Double</td>
<td>Single</td>
</tr>
<tr>
<td>Mean keratometry, diopters</td>
<td>31</td>
<td>27</td>
</tr>
<tr>
<td>Keratometric astigmatism, diopters (median)</td>
<td>46.0 ± 2.7</td>
<td>45.2 ± 2.3</td>
</tr>
<tr>
<td>4.5 ± 2.8 (4.5)</td>
<td>2.2 ± 1.9 (2.0)</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>

*Student t-test for means; **Wilcoxon signed rank test

Wilcoxon signed rank tests. A P-value of 0.05 was considered statistically significant.

RESULTS

Fifteen patients (56%) in the single running suture group had at least 1 postoperative adjustment (12 had 1 adjustment, 2 had 2 adjustments, and 1 had 3 adjustments). First adjustments were typically performed at 3 weeks, and all adjustments were completed by 12 weeks after keratoplasty. The wound was not intentionally opened during these adjustments, and no sutures were broken.

The results are shown in Table 3. Mean keratometry did not differ between the 2 groups at either the 3-month or 12-month examination. Mean and median keratometric astigmatism were significantly less in the single running group than in the double running group at 3 months [2.2 ± 1.9 (2.0) vs 4.5 ± 2.8 (4.5), mean ± SD (median), P <0.001] and at 12 months [3.0 ± 2.2 (2.4) vs 4.2 ± 2.1 (4.0), P = 0.03] after keratoplasty (Figure 1). Within groups, there was no significant change from 3 months to 12 months in either mean keratometry or keratometric astigmatism.

DISCUSSION

This retrospective study was designed to compare postoperative keratometric astigmatism between two commonly used running suture techniques for penetrating keratoplasty. The double running suture technique, first described by McNeill in 1977, was designed to allow early visual rehabilitation by removing the tighter, deeper 10-0 nylon suture 2 to 3 months postkeratoplasty, leaving the more superficially placed and less tight 11-0 nylon suture in place to hold the wound with less distortion.

The adjustable single running suture technique, also described by McNeil in 1989, was initially thought to allow a spontaneous shifting of the suture to the most relaxed and least astigmatic position. However, it was soon learned that suture adjustment was necessary in most cases to reduce the postkeratoplasty keratometric astigmatism. In the present study, we compared the 2 techniques in sequential series performed by the same surgeon with the same trephine system. Results were examined during the first postoperative year while sutures were still in place.

We found a significant reduction in mean keratometric astigmatism in the single running group at 3 months postkeratoplasty. These early postoperative
results confirm those of Lin et al., who found that the adjustable single running suture had less keratometric astigmatism 4 months postkeratopatplasty. In the present study, however, we compared the techniques at 12 months postkeratopatplasty with sutures still in place, finding that a significant difference persisted. Thus the adjustable single running suture technique provided better visual rehabilitation during the first postoperative year. There was a trend toward increasing astigmatism during the first year in the single running suture group, but the increase was not statistically significant. Van Meter also found no increase in astigmatism in the single running technique from 1 to 24 months postadjustment of the suture.

Every patient in the single running group also had an intraoperative suture adjustment, which has been shown to reduce the final keratometric astigmatism and reduce the necessity of postoperative suture manipulation. Fifteen patients (56%) needed additional suture adjustments after keratopatplasty. In the present study, no sutures were broken during adjustment, confirming previous studies.

Although we did not adjust the double running suture in our patients, one study obtained low keratometric astigmatism (2.66 ± 0.24 diopters) with the double running technique by adjusting the 10-0 running suture in the early postoperative period. This suggests that the only important difference between the two suture techniques that we used is the postoperative suture adjustment. Nevertheless, postoperative suture adjustment is easier when only one running suture is present.

The mean keratometry values of 45 to 46 diopters were similar in the 2 groups and also similar to an earlier study of the double running suture technique in which a suction trephine was used. Both these investigations that used suction trephines produced corneas that were steeper by 4 to 5 diopters than when handheld trephines were used previously by the same surgeon. The keratometric astigmatism with the adjustable single running suture technique in the present study was less than that in either previous investigation.

In summary, in this consecutive series of corneal transplants performed by a single surgeon, we found decreased keratometric astigmatism during the first postoperative year in procedures performed by using an adjustable single running suture technique compared with those in which a double running suture technique was used.

**REFERENCES**