Control of Astigmatism Aided by Intraoperative Keratometry

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An evaluation of the final "sutures out" postoperative astigmatism in two groups of keratoconus patients undergoing penetrating keratoplasty is presented. Group I consists of a retrospective evaluation of keratoconus patients who underwent penetrating keratoplasty without using the Troutman Keratometer prior to suturing the button into position. Group II patients had their donor button rotated in the recipient bed until approximate sphericity was indicated by a circular reflex from the Troutman Keratometer before suturing into position. The mean final astigmatism with all sutures removed from Group I was 4.64, SD 1.89, and for Group II 2.27, SD 1.27. Selective positioning of the donor button using the Troutman Keratometer leads to a significant reduction in the final sutures out astigmatism in patients undergoing penetrating keratoplasty for keratoconus.

Key Words: Keratoconus-Astigmatism-Troutman keratometer-Spherical reflex graft rotation-Recipient bed.

If successful results for corneal transplantation are measured in terms of graft clarity, then currently surgeons are reaching their goals in well over 90% of the cases performed (1). Paglen et al. (2) found 90% of corneal grafts to be clear at the end of a 5-year period after reviewing 326 cases of penetrating keratoplasties performed for keratoconus. Similarly, Troutman and Gaster (3) reported 98% clear grafts in 82 penetrating keratoplasties. However, when evaluating success in terms of postoperative "sutures out" astigmatism, the results are less encouraging.

The average keratometric postoperative astigmatism in almost every series to date is -4 diopters (4-11). Various techniques to decrease this seemingly irreducible postoperative sutures out astigmatism have been reported. These include refinement of the trephination techniques in an attempt to produce a perfect match between donor and recipient (12-14), the use of disparate diameter buttons (10, 15-20), and innumerable suture techniques (20,21-23). As previously reported by the authors, selective positioning of the donor cornea in penetrating keratoplasty for keratoconus did not lead to a significant reduction in the final astigmatic error (18).

In the present study, we evaluated a more recent group of patients undergoing penetrating keratoplasty for keratoconus.

METHODS

We evaluated two groups of patients with keratoconus. Group I, the prerotation group, consisted of 21 patients. Group II, the rotation group, consisted of 29 patients. One surgeon (R.C.T.) performed all the surgical procedures, and all postoperative evaluations were performed by another corneal surgeon (S.C.B.). By use of the Troutman corneal punch, all donor buttons were punched from the endothelial surface. A Weck universal trephine handle was used on all recipients to enter the anterior chamber, and trephination was completed with corneal scissors. In all cases, a disparate diameter between donor and recipient of 0.2 mm was used. The donor was punched with an 8.2 mm trephine and the recipient with an 8.0 mm trephine. In a previously published article (25), Dr. Troutman has shown that cutting the donor button from the endothelial surface gives an anterior surface diameter that is 0.2 mm smaller than if cut from the anterior aspect of the donor. After random placement...

<table>
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<tr>
<th>TABLE 1. Postoperative &quot;sutures in&quot; astigmatism</th>
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<tr>
<td>Group I</td>
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<td>3 MO</td>
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<td>6 MO</td>
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D, diopter.
ment in the recipient bed, the donor buttons in the prerotation group were sutured into position without evaluation by the surgical keratometer. In Group II, the rotation group, the donor buttons were rotated within the recipient bed until a spherical reflex was obtained by the keratometer, and then the buttons were sutured into position.

In all cases, six interrupted through and through sutures of 10-0 nylon were used for fixation. A double opposing continuous suture technique was used for final closure. At the end of the procedure, the six interrupted fixation sutures were removed, and with the aid of the Troutman surgical keratometer, tension was adjusted on the continuous sutures to give a final spherical reflex. Steroids were given postoperatively t.i.d. for the first 8 weeks and tapered thereafter so that all medication was discontinued by the sixth postoperative month. Topical tobramycin was prescribed for the first 2 weeks postoperatively and then discontinued. In all patients, the continuous sutures were removed between the 6th and 12th postoperative month.

RESULTS

All keratometry readings were performed with the Gambs keratometer at each successive postoperative period. Average astigmatism was recorded at 1 month, 3 months and 6 months after suture removal. Table 1 presents average astigmatic results and range at each time period for both groups. Of interest is the comparable average astigmatism at 3 months (3.11 diopters for Group I vs. 3.19 diopters for Group II), which shows a significant difference at the 6-month mark (4.36 diopters for Group I vs. 2.54 diopters for Group II). This is compatible to our experience using compression sutures: We find gradual loss of effect of suture tension resisting tissue expansion over time.

After the removal of sutures (Table 2), the average difference between groups remains large (4.64 diopters for Group I vs. 2.27 diopters for Group II) but does not change significantly from the readings at 6 months. This suggests that the influence of healing factors has taken precedence over suturing considerations after the 6-month period.

Figure 1 shows the raw patient data of Groups I and II arranged in order of ascending astigmatism following the removal of sutures. Although this plot suggests a statistically significant difference between the two groups, it does not prove this assertion. Figure 2 shows a notched box and whiskers plot of the data from each group, and demonstrates a statistically significant difference between the two groups by virtue of the nonintersection of the notches of the two plots. In this graphical representation of statistical data, the whiskers represent the range of each group, the box length represents the first and third quartiles, the central line represents the median, and the width of the box represents the square root of the sample size.

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**TABLE 2.** Postoperative “sutures out” astigmatism

<table>
<thead>
<tr>
<th>Group</th>
<th>Average Astigmatism</th>
<th>Range</th>
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<tbody>
<tr>
<td>I</td>
<td>4.64 D</td>
<td>1.5-8 D</td>
</tr>
<tr>
<td>II</td>
<td>2.27 D</td>
<td>0-5 D</td>
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</table>

D, diopter.
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FIG. 2. Notched box and whiskers plot of rotated and nonrotated patient groups following the removal of sutures illustrating range (whiskers), first and third quartiles (length of box), median (central line), and 95% confidence intervals of median (notches) and statistical difference groups by nonintersection of notches.

The notches represent 95% confidence intervals of the median and indicate that in this graphical representation of the data the two groups are statistically different. This graphical representation of the data allows an appreciation of the distribution of data and of the significance of differences between groups. Utilizing a two-tail T-test for significance, the hypothesis that the two groups are not equal is true with a confidence of p < 0.01. In summary, Groups I and II demonstrate a highly statistically significant difference in astigmatism.

DISCUSSION

The authors believe that the most meaningful method of evaluating postkeratoplasty astigmatism is when all sutures are out. The factors causing postkeratoplasty astigmatism are well known to all corneal surgeons. These factors include disparity in trephination of donor and recipient both in diameter and thickness, variability in suture materials, techniques and timing of removal, and recipient corneal disease and its effect on irregular wound healing (22). Despite meticulous attempts to control these factors, there still remains an apparent irreducible amount of postkeratoplasty astigmatism of -4 diopters (7-9,19,22,24).

The use of the surgical keratometer to control induced astigmatism during penetrating keratoplasty was first introduced by Troutman (25). We did not find a statistically significant difference between the groups at the 3-month sutures in. There was a significant difference at the 6-month sutures in. The decrease in postoperative edema with subsequent increased wound healing at the sixth month interval may contribute to these findings. Utilizing the Troutman surgical keratometer and the exact technique and postoperative management described within this paper, the authors were not able to demonstrate significance between the sutures out astigmatism in Groups I and II (18).

The present study does show a statistically significant difference between the rotated and the nonrotated groups. Perhaps more experience with the technique of rotating the graft within the recipient bed in an attempt to obtain sphericity is an explanation. We therefore recommend the use of the intraoperative keratometer as an aid to decrease postoperative sutures out astigmatism.

REFERENCES