Background: A chief morbidity of Graves eye disease is upper eyelid retraction that results in exposure keratopathy and cosmetic deformity.

Objective: To assess the efficacy of graded anterior blepharotomy to treat upper eyelid retraction.

Methods: Fifty eyelids of 32 patients with Graves eye disease–associated upper eyelid retraction, causing symptomatic ocular exposure, were treated with graded, transcutaneous, full-thickness, anterior blepharotomy. Preoperative and postoperative ocular exposure symptoms, upper eyelid position, lagophthalmos, and keratopathy were compared.

Results: At a mean ± SD of 8.5 ± 8.1 months’ (range, 2-35 months) follow-up, more than 90% of preoperative symptoms resolved or improved. Upper eyelid position (P<.001), lagophthalmos (P<.001), and keratopathy (P<.01) were significantly improved. Mild contour abnormalities (all ≤1 mm) occurred in 7 of 50 eyelids. Eyelid crease recession or asymmetry occurred in 4 of 22 patients with postoperative eyelid crease measurements. Complications of ptosis, wound dehiscence, and a full-thickness hole each occurred once. The mean ± SD time taken to perform the procedure was 31.5 ± 8.9 minutes per eyelid.

Conclusions: Graded anterior blepharotomy for upper eyelid retraction is a safe and highly effective surgery for upper eyelid retraction associated with symptomatic Graves eye disease. This technique achieves excellent functional and cosmetic outcomes.

Arch Ophthalmol. 2004;122:55-60

UPPER EYELID RETRACTION IS a common manifestation of Graves eye disease (GED).1,2 Eyelid retraction may result in exposure keratopathy and disturbing symptoms, including blurred vision, photophobia, foreign body sensation, burning, and reactive tearing. Contributing to ocular exposure are impaired excursion of eyelid blink and lagophthalmos.1,3 In addition, the characteristic eyelid retraction of GED results in significant cosmetic deformity and often causes discomfort due to perceived tightness.

Surgical treatment for upper eyelid retraction has included numerous procedures, including Mueller muscle recession or excision3,4; anterior or posterior levator recession with or without adjustable sutures5-10; marginal myotomy11; and placement of natural or synthetic spacer grafts.12-14 These surgical techniques require extensive dissections that may contribute to unpredictable outcomes, such as postoperative ptosis, contour abnormalities, eyelid thickening, eyelid crease recession, and undercorrection.

In 1965, Henderson4,15 described a transconjunctival partial-thickness blepharotomy consisting of a supratarsal conjunctival incision followed by a Mueller muscle transaction with or without levator aponeurotomy. Other authors found this rapid technique to be useful in the management of mild upper eyelid retraction in the absence of abnormal eyelid contour.

In the 1990s, Leo Koornneef developed an novel, rapid transcutaneous, graded blepharotomy technique. On June 10, 1999, Koornneef presented his method at the University of Michigan (Ann Arbor). He reported his method to be effective and yield predictable results, even in patients with severe eyelid retraction. However, owing to his untimely death, his results have remained unpublished.

In this study, we evaluated our results using Koornneef’s technique for the treatment of upper eyelid retraction. This report describes the beneficial effects of graded full-thickness anterior blepharotomy on functional and cosmetic parameters in patients with symptomatic upper eyelid retraction.

METHODS

CLINICAL EVALUATION

The surgeons (V.M.E. and B.R.F.) began using the procedure independently, compared their favorable results after 3 years, and undertook this retrospective study. Included in this study were patients with GED who were operated on...
by these 2 surgeons who are with the Eye Plastic and Orbital Surgery Service of the University at the Michigan Kellogg Eye Center between August 1999 and July 2002 for treatment of symptomatic ocular complications of upper eyelid retraction. The presence and severity of ocular symptoms, including discomfort, tearing, asymmetry, photophobia, and pain/burning were documented preoperatively and postoperatively. Also noted were patient age, time elapsed from the onset of GED, laterality of involvement, and surgical time.

Preoperative and postoperative superficial punctate keratopathy (SPK) was graded from 0 to +4 as follows: 0 = none, 1 = mild, 2 = moderate, 3 = severe, and 4 = epithelial ulceration. The percentage of corneal surface involved with SPK multiplied by the SPK grade was used to derive a corneal exposure index (CEI). The preoperative and postoperative position of the upper eyelid was measured in millimeters from the mid pupil to the upper eyelid margin with the eye in primary gaze and with the coronal plane of the patient’s head perpendicular to the floor. The eyelids were divided into groups based on the severity of upper eyelid retraction as measured by the distance from the center of the pupil (severe, ≥ 7 mm; moderate, 5 to < 7 mm; and mild, ≤ 5 mm). Lagophthalmos, measured during gentle eyelid closure, and eyelid crease height were also measured in millimeters.

To be considered for surgical rehabilitation, all patients had stable upper eyelid retraction for longer than 6 months, except for 1 patient, who had 2 months of stability. Indications for surgery included upper eyelid retraction with symptomatic exposure keratopathy or reflex tearing, whether or not lagophthalmos was present. The 2 surgeons performed all cases.

METHODS

Following informed consent, transcutaneous, graded, full-thickness anterior blepharotomy was performed. After marking for symmetric upper eyelid crease incisions, anesthesia was accomplished with intravenous sedation and local infiltration with 0.3% bupivacaine mixed in equal parts with 1% lidocaine, with epinephrine 1:100,000, or with epinephrine supplementation to 1:30,000 as described by Fante and Elner. The skin was incised in the relevant portion (central, medial, or lateral) of the marked crease. Subsequent dissection through the orbicularis oculi muscle for the length of the incision exposed the levator aponeurosis inferior to its confluence with the orbital septum near the superior border of the tarsal plate. The levator aponeurosis, Mueller muscle, and conjunctiva were then incised at the superior border of the tarsal plate in the area of greatest retraction, creating a full-thickness blepharotomy. The dissection was usually initiated at the junction of the lateral and central thirds of the upper eyelid. The full-thickness blepharotomy was then extended medially and laterally along the superior tarsal border in a graded fashion based on the unsedated patient’s eyelid height and contour while seated and in primary gaze. The upper eyelid was resected to obtain a final postoperative eyelid height between 2 and 4 mm, depending on the severity of exposure symptoms or the height of the other eyelid in unilateral cases. The goal was to reduce the signs and symptoms of ocular exposure while preserving the full binocular visual field. In cases with temporal flare, full-thickness dissection was performed laterally to the superior crus of the lateral canthal ligament, cutting the lateral horn of the levator aponeurosis inferior to the lacrimal gland ducts. The incisions were extended horizontally as needed—in some cases, across the entire eyelid. When extensive medial dissection resulted in flattening of the upper eyelid contour, a single 6-0 polyglyactin mattress suture was placed between the levator aponeurosis and tarsal plate in the flattened area to restore a desirable upper eyelid contour. Limited bipolar cautery was used for hemostasis. The procedure was completed by a simple skin closure with a continuous 6-0 nylon or 6-0 polypropylene suture or interrupted 6-0 fast absorbing plain gut suture. No additional procedures were performed. No temporary tarsorrhaphy or traction sutures were placed.

All groups of data are expressed as mean ± SD. The statistical significance of the differences between preoperative and postoperative groups of measurements was determined using a 2-tailed t test. Differences between groups were considered to be statistically significant at P < .05.

RESULTS

The Koornneef graded, full-thickness anterior blepharotomy was performed on 50 eyelids of 32 patients, with an average follow-up of 8.5 ± 8.1 months (range, 2-35 months). Thirteen patients had less than 6 months of follow-up (4, 3, 3, and 3 patients for 5, 4, 3, and 2 months, respectively). Average patient age was 52 ± 14 years (range, 20-82 years), and there were 30 women and 2 men. The duration of GED averaged 6.8 ± 6.9 years.

The most common initial symptoms caused by GED-associated upper eyelid retraction were discomfort and tearing due to the effects of ocular exposure and asymmetry of eyelid height (Table 1). Postoperatively, 93% of patients’ initial symptoms were resolved or improved. Symptoms remained unchanged only in those who had intercurrent factors, namely, dryness due to radiation therapy or lower eyelid retraction or asymmetry due to postoperative ptosis.

The upper eyelid height was improved by surgery in all 50 eyelids (Figure 1 and Table 2). The difference between preoperative and postoperative height was highly statistically significant regardless of the degree of preoperative retraction severity (severe, moderate, and mild; P < .001 for all (Table 2; Figure 2)). The final postoperative eyelid heights were not statistically different regardless of whether initial retraction severity was severe, moderate, or mild (Figure 2). However, the final eyelid heights obtained after recession in patients with severe retraction were more variable, with an SD of 1.29 (Table 2). This resulted in fewer patients in the severe group (53%), with final eyelid heights in the target range

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Table 1. Symptoms of Graves Eye Disease Retraction and Effect of Blepharotomy in 32 Patients

<table>
<thead>
<tr>
<th>Preoperative Symptoms</th>
<th>No. of Patients</th>
<th>Resolved</th>
<th>Partial Improvement</th>
<th>Unchanged</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discomfort (dryness and foreign body sensation)</td>
<td>17</td>
<td>10 (59)</td>
<td>6 (35)</td>
<td>1 (6)†</td>
</tr>
<tr>
<td>Tearing</td>
<td>16</td>
<td>5 (31)</td>
<td>9 (56)</td>
<td>2 (13)‡</td>
</tr>
<tr>
<td>Asymmetry</td>
<td>11</td>
<td>10 (82)</td>
<td>0</td>
<td>1 (9)§</td>
</tr>
<tr>
<td>Photophobia</td>
<td>6</td>
<td>6 (100)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pain/burning</td>
<td>7</td>
<td>4 (57)</td>
<td>3 (43)</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>57</td>
<td>35 (61)</td>
<td>18 (32)</td>
<td>4 (7)</td>
</tr>
</tbody>
</table>

*Data are given as number (percentage) of patients.
†Radiotherapy-induced dryness.
‡One patient, radiotherapy-induced dryness; 1 patient, lower eyelid retraction.
§One patient, postoperative ptosis.
of 2 to 4 mm compared with those in the moderate (81%) and mild (93%) groups (Table 2). Postoperative eyelid heights of patients followed up for 6 months or more after surgery (3.22 ± 0.84 mm) did not differ significantly (P = .32) from those of patients with follow-up ranging from 2 to 6 months (3.48 ± 0.94 mm).

Preoperative lagophthalmos was present in 30 eyelids. The difference between preoperative and postoperative lagophthalmos to obtain lower upper eyelid height for keratopathy after radiation therapy. Before (G) and after (H) staged bilateral blepharotomies, the second stage consisting of medial blepharotomies.

Table 2. Severity of Eyelid Retraction: Effect of Blepharotomy in 50 Eyelids*

<table>
<thead>
<tr>
<th>Degree of Eyelid Retraction, mm</th>
<th>No. of Eyelids</th>
<th>Preoperative Eyelid Height, mm</th>
<th>Postoperative Eyelid Height, mm</th>
<th>Significance of Difference Between Preoperative and Postoperative Eyelid Height, P Value</th>
<th>Amount of Recession, mm</th>
<th>No. (%) of Eyelids With Height ≥2 to ≤4 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe (height ≥7.0)</td>
<td>15</td>
<td>7.73 ± 0.62</td>
<td>3.57 ± 1.29</td>
<td>&lt;.001</td>
<td>4.2 ± 1.2</td>
<td>8 (53)</td>
</tr>
<tr>
<td>Moderate (height &gt;5.0 to &lt;7.0)</td>
<td>21</td>
<td>5.98 ± 0.40</td>
<td>3.33 ± 0.70</td>
<td>&lt;.001</td>
<td>2.6 ± 0.7</td>
<td>17 (81)</td>
</tr>
<tr>
<td>Mild (height ≤5.0)</td>
<td>14</td>
<td>4.46 ± 0.50</td>
<td>3.07 ± 0.51</td>
<td>&lt;.001</td>
<td>1.4 ± 0.5</td>
<td>13 (93)</td>
</tr>
</tbody>
</table>

*Data are given as mean ± SEM unless otherwise indicated.
operative lagophthalmos was statistically significant for eyelids with all degrees of preoperative eyelid retraction (severe, \(P < .001\); moderate, \(P < .001\); and mild, \(P < .01\)) (Figure 3). There was no statistical significance when residual postoperative lagophthalmos was compared among eyelids with varying degrees of preoperative retraction severity or lagophthalmos. Lagophthalmos resolved in 13 (81%) of 16 eyes with preoperative lagophthalmos of 1.0 mm or less and in 10 (71%) of 14 eyes with preoperative lagophthalmos of 1.5 mm or more (\(P < .001\), for both groups). Of the 7 eyes with residual lagophthalmos, 4 eyes exhibited improvement, while only 3 showed no change.

Preoperative SPK was present in 49 of 50 eyes. The initial CEI did not differ significantly based on the severity of preoperative eyelid retraction (Figure 4). The postoperative reduction in CEI was statistically significant for all 3 groups (severe, moderate, and mild; \(P < .01\) for all). There were no significant differences among the final CEI of the retraction severity groups.

Of the 32 patients undergoing upper eyelid blepharotomy, 14 (44%) had no measurable postoperative eyelid height asymmetry, and 17 other patients (53%) had asymmetry of 1 mm or less (Table 3). Only 1 patient (3%) had asymmetry of greater than 1.0 mm due to postoperative ptosis. Patients with mild severity of initial retraction in their highest eyelid had the least chance of having postoperative asymmetry. However, the amount of residual postoperative asymmetry was not statistically different among the retraction severity groups. The target final eyelid height of between 2 and 4 mm was achieved in 24 patients (75%) (Table 4) and 38 eyelids (76%) (Table 2).

Postoperative upper eyelid crease recession greater than 1 mm was present in 10 (45%) of 22 patients for which data on final eyelid crease measurements were available. However, clinically significant, surgically induced eyelid crease height greater than 10 mm or induced eyelid crease asymmetry of 2 mm or more occurred in only 4 patients (18%) in whom these measurements were made (Table 5). Mild contour abnormalities were noted in 7 patients (22%). Contour abnormalities, occurring in 7 eyelids (14%) of 7 patients (Table 5), were mild and less than 1 mm by comparing bilateral eyelid heights in corresponding sagittal planes. No patient noted any abnormality in eyelid crease height, although recession or asymmetry was induced in 4 (13%) of 32 patients.

No complications occurred during operations that averaged 31.5 ± 8.9 minutes per eyelid (range, 18-57 minutes). Postoperative complications included ptosis, overcorrection of eyelid contour requiring suture removal, wound dehiscence, and a full-thickness hole in 1 patient each. Treatment of the 2 × 1-mm hole was offered at 1 week and 2 years postoperatively but was declined since it did not bother the patient. No patient developed wound infection or complained of postoperative ocular surface irritation.

Intraoperative biopsy specimens from 3 eyelids that had not undergone previous operations where irregular conjunc-

### Figure 2

Effect of blepharotomy on upper eyelid height. Eyelids were divided into groups based on the severity of preoperative eyelid retraction: severe, \(>7\) mm; moderate, \(5 \text{ to } 7\) mm; mild, \(\leq 5\) mm. Asterisk indicates \(P < .001\).

### Figure 3

Effect of blepharotomy on lagophthalmos. Eyelids were divided into groups based on the severity of preoperative eyelid retraction as described in Figure 2. One asterisk indicates \(P < .01\); 2 asterisks, \(P < .001\).

### Figure 4

Effect of blepharotomy on corneal exposure. The percentage of corneal surface involved with superficial punctate keratopathy (SPK) multiplied by the SPK grade (0 to 4+) was used to derive a corneal exposure index. Eyelids were divided into groups based on the severity of preoperative eyelid retraction as described in Figure 2. Asterisk indicates \(P < .01\).
Table 3. Asymmetry in 32 Patients After Full-Thickness Blepharotomy*

<table>
<thead>
<tr>
<th>Degree of Preoperative Retraction in Highest Eyelid</th>
<th>No. of Patients</th>
<th>No Postoperative Asymmetry</th>
<th>Postoperative Asymmetry ≤1 mm</th>
<th>Postoperative Asymmetry &gt;1 mm</th>
<th>Asymmetry, Mean ± SEM, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe</td>
<td>11</td>
<td>2 (18)</td>
<td>8 (73)†</td>
<td>1 (9)</td>
<td>0.78 ± 0.36</td>
</tr>
<tr>
<td>Moderate</td>
<td>12</td>
<td>5 (42)</td>
<td>7 (58)</td>
<td>0</td>
<td>0.57 ± 0.19</td>
</tr>
<tr>
<td>Mild</td>
<td>9</td>
<td>7 (78)</td>
<td>2 (22)</td>
<td>0</td>
<td>0.75 ± 0.35</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>14 (44)</td>
<td>17 (53)</td>
<td>1 (3)</td>
<td></td>
</tr>
</tbody>
</table>

*Data are given as number (percentage) of patients unless otherwise indicated.
†One patient greater than 1 mm.

Table 4. Final Eyelid Height After Blepharotomy in 32 Patients*

<table>
<thead>
<tr>
<th>Degree of Preoperative Retraction in Highest Eyelid</th>
<th>No. of Patients</th>
<th>Height &lt;2.0 mm</th>
<th>Height ≥2.0 to ≤4.0 mm</th>
<th>Height &gt;4.0 to &lt;5.0 mm</th>
<th>Height ≥5.0 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe</td>
<td>11</td>
<td>1 (9)</td>
<td>5 (46)</td>
<td>3 (27)</td>
<td>2 (18)</td>
</tr>
<tr>
<td>Moderate</td>
<td>12</td>
<td>0</td>
<td>10 (83)</td>
<td>2 (17)</td>
<td>0</td>
</tr>
<tr>
<td>Mild</td>
<td>9</td>
<td>0</td>
<td>9 (100)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>1 (3)</td>
<td>24 (75)</td>
<td>5 (16)</td>
<td>2 (6)</td>
</tr>
</tbody>
</table>

*Data are given as number (percentage) of patients unless otherwise indicated.

Table 5. Eyelid Contour and Crease Irregularities

<table>
<thead>
<tr>
<th>Irregularity</th>
<th>No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contour abnormalities</td>
<td>3</td>
</tr>
<tr>
<td>Lateral peak</td>
<td>2</td>
</tr>
<tr>
<td>Central flattening</td>
<td>2</td>
</tr>
<tr>
<td>Medial ptosis</td>
<td>2</td>
</tr>
<tr>
<td>Induced eyelid crease recession,*</td>
<td>4</td>
</tr>
<tr>
<td>&gt;10 or ≥2 mm of asymmetry between sides</td>
<td></td>
</tr>
</tbody>
</table>

*Data available on 22 of 32 patients.

The inflammatory processes of GED diffusey affect orbital, eyelid, and facial tissues and result in adipocyte proliferation, extracellular matrix deposition, and fibrosis within these tissues. Although upper eyelid retraction, the most common clinical feature of GED, is classified clinically as myogenic, the pathogenesis of GED suggests that the retracted eyelid is diffusely affected by the disease.

Modifying the first proposed surgical methods for the treatment of GED-associated upper eyelid retraction, Henderson proposed a partial-thickness posterior blepharotomy approach in 1965. His method used a Mueller muscle myotomy for mild or moderate retraction and additional graded division of the levator aponeurosis for severe retraction. While the technique was rapid and rarely overcorrecting, undercorrection and lateral temporal flare were common, limiting its effective use to patients with mild retraction and limited temporal flare. Subsequently, numerous modifications of Henderson’s technique have been proposed for the treatment of GED-associated upper eyelid retraction, but quantitative studies demonstrating consistent, reproducible, and graded recession to obtain desired eyelid height and symmetry are few. Most of these techniques use either (1) transconjunctival Mueller muscle myotomy or excision or (2) transcutaneous levator aponeurotomy or myotomy with or without Mueller muscle myotomy and excision with additional modifications, including levator transpositions and myoplasties, eyelid spacer grafts, and adjustable sutures. None of the reported surgical methods use a full-thickness technique or address the diffuse nature of GED disease in the retracted eyelid, a contention supported by the conjunctival fibrosis we observed histopathologically in 3 cases. This shortcoming may be responsible for the highly variable results reported to date for surgical correction of GED-associated upper eyelid retraction.

The Koornneef full-thickness anterior blepharotomy technique addresses the diffuse, full-thickness alterations of the eyelid, including those of the skin and conjunctiva, which together result in the degree of upper eyelid retraction seen clinically. A transconjunctival approach does not completely address the orbicularis oculi muscle fibrosis, since the muscle is present immediately beneath the epithelium and intervening reticular dermis. The benefits of the transcutaneous incision are not lost when skin closure is performed by gentle apposition. Compared with posterior approaches, the anterior blepharotomy technique permits better control of the eyelid contour and height because the eyelid is not deformed by inversion or stretching; rather, the eyelid rests in its natural position.

Our results indicate that the Koornneef full-thickness anterior blepharotomy permits graded recession of the retracted upper eyelid to achieve consistent final eyelid height (Table 2 and Figure 2) and contour (Table 5), regardless of the severity of preoperative eyelid retraction. The highly accurate, graded ameliorative effect of the blepharotomy tech-
nique is evidenced by comparison of postoperative eyelid heights, which were not statistically different regardless of initial retraction severity (Table 2). Eleven eyelids were undercorrected, with final eyelid heights of greater than 4 mm, occurring more often in the severe group (7 eyelids) (Table 2). Many of the undercorrections occurred when the target eyelid height was 4 mm, leaving only a small margin of error. In such patients, a higher target may limit the predictability of the graded procedure to fall within our target range.

Lateral temporal flares is easily addressed when the lateral horn is cut through an anterior approach (Figure 1C and D), while medial overcorrection causing ptosis and contour deformity is rare. In our study, postoperative central flattening is avoided by either (1) placing a dissolvable suture at the apex of the eyelid arch, as performed in 5 patients, or (2) performing a later, separate full-thickness blepharotomy to address medial retraction in a staged fashion as we did in 2 patients with severe retraction (Figure 1G and H).

Ninety-three percent of preoperative symptoms were resolved or improved by the full-thickness blepharotomy technique, indicating the effectiveness of this procedure (Table 1). The ameliorative effects of the blepharotomy on symptoms were accompanied by complete resolution of lagophthalmos in 77% of eyes and reduction of exposure keratopathy by an average of 77%. Cosmetically, all patients except for one, whose results were complicated by ptosis, had resolution of symmetric asymmetry (Table 1). The postoperative contour abnormalities in 7 eyelids (14%) (Table 5) were all unilateral, mild, and asymptomatic. Likewise, no patient complained of any abnormality in eyelid crease height or asymmetry.

Limited dissection and short operative time reduce postoperative morbidity and complications inasmuch as dissection is directly posterior, limiting superior and inferior disruption of multiple tissue planes. Some of the advantages of the technique include preservation of (1) levator aponeurosis fibers forming the eyelid crease; (2) the orbital septum and fat pads; (3) levator aponeurosis/Mueller muscle/conjunctival complex in the superior portion of the eyelid; and (4) support of the superior conjunctival fornix. Maintenance of these relationships reduces iatrogenic eyelid deformities and spread of hemorrhage and edema into these structures. In evaluating Henderson’s technique, Oliver and Fells\(^3\) proposes that leaving the conjunctiva unsutured leads to conjunctival shortening and recurrence of eyelid retraction. Our results, however, show that dissection through the conjunctiva is an essential part of the surgical correction, since GED-induced fibrosis involves the conjunctival substantia propria. Thus, conjunctival release improves outcomes. It also allows blood drainage from the surgical site, thereby preventing eyelid height and contour abnormalities caused by the weight of accumulated hematoma and edema fluid.

This simple, rapid method does not require implantation of foreign material or permanent sutures. Postoperatively, no taping or traction suture is necessary. Furthermore, we have performed this technique on eyelids retracted owing to overcorrected ptosis (4 cases) or trauma (2 cases). In all cases, eyelid height within less than 1 mm of the desired correction, with excellent contour, was obtained in this small cohort. Koornneef’s graded, full-thickness anterior blepharotomy technique targets the functional and cosmetic needs of patients with GED-associated upper eyelid retraction, regardless of severity. This technique effectively treats the signs and symptoms of exposure keratopathy and lagophthalmos while obtaining excellent cosmetic results, as shown by analysis of our pooled data of 2 surgeons working independently.

Submitted for publication February 4, 2003; final revision received July 25, 2003; accepted August 19, 2003.

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Previous Presentation: This article is based on a presentation given at the Annual Meeting of the American Ophthalmological Society, May 17-20, 2003, Santa Barbara, CA; and subsequently published in Transactions of the American Ophthalmological Society (2003; 101:67-76) and is published in the Archives of Ophthalmology after peer review and revision.

REFERENCES