New Grading System to Improve the Surgical Outcome of Multirecurrent Pterygia

Jingbo Liu, MD, PhD; Yao Fu, MD, PhD; Ying Xu, MD; Scheffer C. G. Tseng, MD, PhD

Objective: To report a new grading system and surgical outcome by sealing the gap between the conjunctiva and Tenon capsule.

Methods: A total of 32 eyes of 30 patients with pterygia were managed at the Ocular Surface Center from January 1, 2002, through December 31, 2010. The eyes were consecutively operated on by recession; sealing of the gap; covering of exposed medial rectus muscle by amniotic membrane, conjunctival autograft, or oral mucosal graft (OMG); and covering of the bare sclera with amniotic membrane. Main outcome measures were recurrence, diplopia, and caruncle morphological characteristics.

Results: Caruncle grading strongly correlated with residual conjunctiva \( (P = .01) \), severity of diplopia \( (P = .001) \), and overall success rate \( (P = .05) \). Amniotic membrane transplantation alone was successful in 23 eyes with residual conjunctiva of 27.8 (10.1) mm, which was significantly longer than those in 6 cases in which amniotic membrane transplantation failed \( (13.1 [11.4] \text{ mm, } P = .007) \) and those in 8 cases in which amniotic membrane transplantation was successful but that required an additional conjunctival autograft or oral mucosal graft \( (10.9 [10.4] \text{ mm, } P = .001) \). During mean (SD) follow-up of 27.5 (20.5) months, 30 of 32 eyes (94%) achieved total success without recurrence and diplopia and normal caruncle in 17 of 21 eyes (81%) with abnormal caruncle before surgery. One eye (3%) developed corneal recurrence and was lost to follow-up, and 1 eye (3%) was left with a depressed caruncle and residual diplopia on adduction.

Conclusions: Caruncle morphological characteristics and residual conjunctiva measurement help grade the severity of recurrent pterygium, guide surgical techniques, and predict outcomes. Sealing of the gap is important to create a strong barrier for preventing recurrence, restoring caruncle morphological characteristics, and regaining full motility in multirecurrent pterygia.


Pterygium is a common ocular surface disease characterized by abnormal epithelial tissues and subconjunctival fibrovascular overgrowth onto the cornea (Figure 1A and D). Tan et al\(^1\) proposed to estimate the amount of fibrovascular tissue, sandwiched between the conjunctiva and the Tenon capsule, by the visibility of the episcleral vessels under slitlamp examination as a way to predict the surgical outcome of primary pterygia. Such fibrovascular growth is more extensive in recurrent pterygia, leading to symblepharon and motility restriction.\(^2\) It remains unclear whether grading of fibrovascular tissue can also be used to predict the surgical outcome of recurrent pterygia and foretell the surgical outcome.

As in primary pterygia, bare sclera excision of conjunctiva together with fibrovascular tissues is adopted in recurrent pterygia. After that, several strategies have been advocated to curtail recurrence. The first emphasizes “thorough” removal of fibrovascular tissue, initially advocated by Barraquer\(^3\) in 1980, stressed by Prabhasawat et al\(^4\) in 1997, and recently reemphasized by Hirst.\(^5\) The second is to suppress the regrowth of fibrovascular tissue by intraoperative application of mitomycin C.\(^4,6,8\) The third is to cover the bare sclera with a conjunctival autograft (CA),\(^1,4,5,9,11\) conjunctival limbal autograft,\(^12-15\) or cryopreserved amniotic membrane (AM).\(^4,6,7,11\) Intriguingly, despite these efforts, recurrence rates remain highly variable from 0% to 52.6%. Besides patient demographics,\(^6,17\) ethnic and environmental factors,\(^18\) pterygium morphological characteristics,\(^1\) different surgeons,\(^19\) and postoperative regimen,\(^20-22\) we wonder whether there might be as-yet-unknown surgical variables that contribute to such variable outcomes.

We theorize that a gap is inevitably created between the conjunctiva and the

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Author Affiliations: Ocular Surface Center and Ocular Surface Research & Education Foundation, Miami, Florida (Drs Liu, Fu, and Tseng); Eye Hospital, Wenzhou Medical College, Wenzhou, China (Dr Liu); Department of Ophthalmology, Ninth People’s Hospital, Medical School of Shanghai Jiaotong University, Shanghai, China (Dr Fu); and Department of Physiology and Cell Biology, The Ohio State University, Columbus (Dr Xu).
Tenon capsule by bare sclera excision (Figure 1B and E). Such a gap is more widely open in the caruncle, where fibrovascular tissue is more abundant. Hence, failure of sealing such a gap may lead to recurrence. We thus retrospectively reviewed our experience of sealing the gap by 3 different approaches practiced during 8 years for multirecurrent pterygia.

METHODS

This study was approved by the institutional review board of Baptist Hospital of Miami/South Miami Hospital Inc, Miami, Florida. A total of 32 eyes of 30 patients were managed at the Ocular Surface Center (Miami, Florida) from January 1, 2002, through December 31, 2010, with a minimum follow-up of 8 months, and subdivided into 3 groups. In the anchoring suture (AS) group (from 2002 to 2004), the gap was sealed with 4-0 black silk AS as reported for fornix reconstruction.\(^2^3\) In the fibrin glue (FG)/AS group (from 2005 to 2008), the gap was sealed with FG before AS. In the running suture (RS) group (from 2009 to 2010), the gap was sealed with a 9-0 nylon RS.

All patients received photographic documentation of all preoperative and postoperative visits and digital recordings of their eyeball movement and surgical procedures. Demodex blepharitis confirmed by microscopic examination\(^2^4,2^5\) or dry eye by the fluorescein clearance test\(^2^6,2^7\) were successfully managed by eyelid scrub using tea tree oil\(^2^8,2^9\) and punctal occlusion, respectively, before pterygium operations.

SURGICAL PROCEDURES

Written informed consent regarding the surgical procedures, alternatives, risks, and benefits was obtained from each patient. The advantages and disadvantages of the off-label use of FG and mitomycin C in ophthalmology were also discussed. All operations were performed by the same surgeon (S.C.G.T.) with the patients under general (22 eyes) or topical (10 eyes) anesthesia. For all eyes, epinephrine (1:1000) (Hospira Inc) was instilled for hemostasis control, whereas a 7-0 Vicryl (Ethicon; Johnson & Johnson) traction suture was placed at superior and inferior limbal sclera to achieve adequate exposure, estimate motility restriction, and put the medial rectus muscle under tension so that the cicatrix was safely released from the muscle without using a muscle hook.

RECESSION OF PTERYGIUM SYMBLEPHARON

An incision separated the head from the peripheral corneal, limbal, and perilimbal bulbar sclera (Figure 2A), followed by dissection on the bare sclera plane to the superior and the inferior bulbar areas before separating the cicatrix from the rectus muscle surface (Figure 2B). Subconjunctival fibrovascular tissue, including the Tenon capsule, was removed from the bulbar sclera as previously described\(^6\) and recessed to the fornix. In the AS group, the subconjunctival tissue was removed, whereas it was left intact in the FG/AS and the RS groups (Figure 2C). The gap between the conjunctiva and the Tenon capsule was identified by grabbing the conjunctiva with two 0.12-mm forceps (Figure 1E). The corneal surface was smoothed with a No. 64 blade and/or a dental burr.

INTRAOPERATIVE APPLICATION OF MITOMYCIN C

Weckcel sponges (Medtronic Ophthalmics) soaked with 0.04% mitomycin C were inserted into the gap covering the entire fornical region for durations indicated in Table 1 before being irrigated with half a bottle of balanced salt solution (Alcon Laboratories Inc).

SEALING OF THE GAP

In the AS group, the gap was sealed by 4-0 black silk double-armed mattress sutures (Ethicon; Johnson & Johnson) as reported for symblepharon lysis.\(^2^3\) One such mattress suture was placed to span between the 2 rectus muscles in the superior nasal fornix to pull the sealed tissue away from the sclera and se-
cure it to the skin by a bolster (Figure 2D). Another anchoring suture was placed in the inferior nasal fornix (Figure 2E). In the FG/AS group, the gap was sealed by FG (Tisseel; Baxter) before AS (Figure 2F). In the RS group, the gap was sealed by a 9-0 nylon RS (Ethicon; Johnson & Johnson) to encompass the entire fornix with or without AS (Figure 2G).

COVERING OF THE RECTUS MUSCLE

The exposed muscle was covered by a small cryopreserved AM (AmnioGraft; Bio-Tissue) with the stromal surface facing down by FG. If the residual conjunctiva (RC) was missing, CA from the same eye or the fellow eye or oral mucosal graft (OMG) from the inferior labial oral cavity was harvested to attach to the sealed gap in the caruncle with a 8-0 Vicryl RS (Ethicon; Johnson & Johnson) and to the side of muscle belly with 2 interrupted 9-0 nylon sutures before further adhesion by FG underneath (Figure 3).

AM TRANSPLANTATION

A larger AM was transplanted to cover the entire bare sclera and the rectus muscle using FG (Figure 2H) to achieve a smooth surface with an elevated caruncle (Figure 2I). Tobramycin and dexamethasone ointment (Alcon Laboratories Inc) was applied in the eye.

POSTOPERATIVE MANAGEMENT AND FOLLOW-UP

Postoperatively, topical 0.3% ofloxacin drops (Allergan Inc) were applied 3 times per day together with 1% prednisolone acetate (Allergan Inc) every 2 waking hours for 4 weeks. At that time, use of ofloxacin was discontinued if epithelization was completed, whereas topical corticosteroid was tapered from 4 times a day for the next 4 weeks. The AS was removed in 2 to 3 weeks. The 9-0 nylon RS was left intact because it was buried behind the caruncle. Subconjunctival injections of triamcinolone acetonide (Bristol-Myers Squibb) in a total amount between 8 and 12 mg, subdivided into 3 depots in superior and inferior fornices and nasal caruncle, were performed, as reported, in the office if the surrounding conjunctiva exhibited persistent inflammation at 1-month postoperative or subsequent visits.

GRADING SYSTEMS

External photographs were taken at primary and extreme right and left gazes at ×10 magnification under slitlamp examina-
tion using a Coolpix 5000 camera (Nikon Corp). Recurrence was graded as G1 (normal), G2 (fine episcleral vessels), G3 (conjunctival recurrence), or G4 (corneal recurrence) as described.4 Diplopia was graded as 0 (none), D1 (diplopia 20° to 40° from the primary gaze), D2 (diplopia <20° from but not at the primary gaze), or D3 (diplopia at the primary gaze) as described.13 The caruncle morphological characteristics were graded as C1 (normal elevated dome shape, Figure 4A), C2 (normal elevated dome shape, but the semilunar fold was displaced toward the limbus, Figure 4B), or C3 (flattened, Figure 4C). Persistent conjunctival inflammation at the 1-month visit was graded as 0 (none), I (mild), II (moderate), or III (severe) as reported.21 The RC was measured in millimeters from the recurrent pterygial head to the clinically evident caruncle (Figure 4D and E) by displaying the external photograph of the extreme gaze in Microsoft Office Powerpoint 2003 (Microsoft Corp) (height, 3.75 in; width, 5 in; and magnification, 67%) and using E-ruler 1.1 (http://www.mycnknow.com). To aid others who might use different cameras, we also measured the horizontal diameter of the fellow cornea at the primary gaze in the same manner as the reference for each patient (Figure 4F) and divided it by the RC to determine the residual to horizontal (RH) ratio.

OUTCOME MEASURES AND STATISTICAL ANALYSES

The outcome measures were resolution of recurrence and binocular diplopia and restoration of a normal caruncle. All data were reported as mean (SD) and analyzed using SPSS statistical software, version 17.0 (SPSS Inc). Differences in continuous variables between groups were evaluated by 1-way analysis of variance. Categorical variables between groups were analyzed using the χ² test. Differences in the RC and RH ratio between cases successfully and unsuccessfully treated were analyzed by the 2-sample t test. Correlation among the variables was analyzed by the Pearson or Kendall tau correlation procedure when appropriate. P < .05 was considered statistically significant.

RESULTS

The study consisted of 32 eyes of 30 patients, including 18 men and 12 women, with a mean age of 52.2 (12.4) years (range, 26–72 years). Double-head recurrent pterygia was noted in 4 eyes of 3 patients (12%), with 1 pa-
tient having pterygia in both eyes. One eye (patient 24) had motility restriction in all directions due to fat adherence syndrome.30 Recurrence developed after 2.5 (1.9) (range, 1-8) prior operations using AM transplantation with mitomycin C (n=16), CA (n=13), AM transplantation (n=9), AM transplantation with CA and mitomycin C (n=3), mitomycin C alone (n=3), CA with mitomycin C (n=1), conjunctival limbal autograft (n=1), bare sclera (n=1), radiation (n=1), and unknown surgical techniques (n=31) (Table 1).

The caruncle morphological characteristics were graded C1 in 11 eyes (34%), C2 in 9 eyes (28%), and C3 in 12 eyes (38%). Binocular diplopia was noted in 26 eyes (81%) and graded as D1 in 16 eyes (62%), D2 in 8 eyes (31%), and D3 in 2 eyes (8%). The caruncle grading was significantly correlated with severity of diplopia (P = .001), RC length (P = .01), and RH ratio (P = .01) (Table 2). The caruncle grading also correlated well with the overall surgical outcome of no recurrence, full ocular motility, and C1 caruncle (P = .05). No correlation was noted between caruncle grading and prior operations.

Operations were uneventfully performed in all eyes. Postoperatively, pain was missing in 27 patients (84%) but only mild on eye movement in the remaining 5 patients. Epithelization was completed on the AM-covered area at the first-month visit in all eyes.
Among them, 7 eyes received intraoperative mitomycin C and 1 eye (patient 1) received CA to cover the muscle. For 47.1 (21.1) months, no recurrence was noted, 7 of 8 eyes with diplopia gained full motility, and 3 of 4 eyes with preoperative abnormal caruncles restored a C1 appearance (Figure 5A-D). The only eye unsuccessfully treated (patient 5) had no RC after 9 prior operations, was left with D2 diplopia and C2 caruncle, and was enrolled in the RS group.

From 2005 to 2008 when FG was available, the FG/AS group (13 eyes) received sealing of the gap by FG and AS without thorough removal of fibrovascular tissue.

Figure 3. Methods of covering the medial rectus muscle. For eyes with sufficient residual conjunctiva (RC), amniotic membrane is used to cover the anterior portion of the muscle with fibrin glue first (A) followed by the posterior portion guided by a muscle hook (B). In contrast, for eyes without sufficient RC, conjunctival autograft (CA) (C and D) or oral mucosal graft (OMG) (E and F) is used. The anterior edge of the CA (C) or OMG (E) is sutured with a 8-0 Vicryl running suture to the conjunctival edge of the sealed gap, whereas the posterior edge is secured by 2 interrupted 10-0 nylon sutures (D); the graft can then be further secured to the muscle surface by fibrin glue smoothened by a muscle hook (F).

Figure 4. Grading of caruncle morphological characteristics and residual conjunctiva (RC) and residual to horizontal (RH) ratio measurements. The caruncle is graded as normal, C1 (A, arrow); slightly flattened, C2 (B, arrow); and flattened, C3 (C, arrow). As a way of estimating conjunctival shortage, RC is measured from the head of the recurrent pterygium to the first evidence of the caruncle using photographs taken at the extreme gaze in an eye with C1 caruncle (D, with an RC of 38.4 mm and an RH ratio of 1.07) and an eye with C2 caruncle (E, with an RC of 27.3 mm and an RH ratio of 0.78), where the border of caruncle is judged by the presence of the underlying sebaceous gland. The horizontal diameter of the fellow cornea at the primary gaze was defined and measured (F).

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Among them, 6 eyes received mitomycin C, and 2 eyes with short RC (patients 14 and 15) received AM or OMG to cover the muscle. For 24.7(13.6) months, 10 eyes had no recurrence, 9 eyes with preoperative diplopia achieved full ocular motility, and 6 of 11 eyes with abnormal caruncles restored a C1 appearance (Figure 6A-D). Compared with the AS group, the FG/AS group had significantly more recurrence ($P < .001$), diplopia ($P = .01$), and persistent inflammation ($P = .04$). One eye (patient 23) developed G4 recurrence and D1 diplopia 5 months after surgery and was lost to follow-up. Two eyes (patients 20 and 22) with G3 recurrence (Figure 6E and F) and 1 eye (patient 21) with residual D1 diplopia were enrolled in the RS group (Figure 6G and H).

From 2009 to 2010, the RS group (14 eyes) received sealing of the gap by RS. Among them, 1 eye received mitomycin C and 5 eyes had additional AS. For 9.8(3.2) months, 8 eyes with 12.6 to 48 mm of RC had no recurrence and gained full ocular motility, and 2 of 3 eyes with abnormal caruncles restored a C1 appearance (Figure 7A and B). One eye (patient 28) with RC of 6.3 mm had G4 recurrence, D2 diplopia, and C3 caruncle (Figure 7C and D). The remaining 5 eyes, including 4 eyes unsuccessfully treated as previously mentioned (patient 5 from the AS group, patients 21 and 22 from the FG/AS group, and patient 28 from the RS group), had short RC from 0 to 13.5 mm and received CA. During the follow-up of more than 8 months, all 5 eyes had no recurrence and C1 caruncle (Figure 7E and F), and 4 of 5 eyes achieved full motility without diplopia. The remaining 1 eye (patient 5) had no recurrence but was left with residual D2 diplopia only at adduction and a depressed hollow space in the nasal caruncle, causing dry eye and incomplete closure. This complication was the result of repeated removal of subconjunctival fibrovascular tissue (Figure 5E-H).

Table 2. Correlation of Caruncle Morphological Findings With RC, RH Ratio, Diplopia, and Surgical Outcome

<table>
<thead>
<tr>
<th>Variable</th>
<th>C1 (%)</th>
<th>C2 (%)</th>
<th>C3 (%)</th>
<th>$P$ Value</th>
</tr>
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<tr>
<td>Eyes, No.</td>
<td>11</td>
<td>8</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Preoperative correlation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior surgical times, mean (SD)</td>
<td>2.1 (1.5)</td>
<td>1.9 (0.9)</td>
<td>3.4 (2.4)</td>
<td>.24</td>
</tr>
<tr>
<td>RC, mean (SD), mm</td>
<td>30.8 (10.7)</td>
<td>26.0 (12.5)</td>
<td>19.1 (10.7)</td>
<td>.01</td>
</tr>
<tr>
<td>RH ratio, mean (SD)</td>
<td>0.8 (0.3)</td>
<td>0.7 (0.4)</td>
<td>0.5 (0.3)</td>
<td>.01</td>
</tr>
<tr>
<td>Diplopia, %</td>
<td>46</td>
<td>12</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>36</td>
<td>88</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>18</td>
<td>0</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Postoperative correlation, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persistent inflammation</td>
<td>54</td>
<td>56</td>
<td>77</td>
<td>.88</td>
</tr>
<tr>
<td>Recurrence</td>
<td>0</td>
<td>22</td>
<td>15</td>
<td>.31</td>
</tr>
<tr>
<td>Diplopia</td>
<td>0</td>
<td>22</td>
<td>23</td>
<td>.14</td>
</tr>
<tr>
<td>Recurrence or diplopia</td>
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<td>33</td>
<td>23</td>
<td>.19</td>
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<tr>
<td>Caruncle morphological characteristics</td>
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<td>33</td>
<td>38</td>
<td>.73</td>
</tr>
<tr>
<td>Recurrence of diplopia or caruncle morphological findings</td>
<td>0</td>
<td>44</td>
<td>38</td>
<td>.05</td>
</tr>
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</table>

Abbreviations: C (1-3), caruncle grading; RC, residual conjunctiva; RH ratio, residual to horizontal ratio.

Figure 5. Representative surgical outcome in the anchoring suture group. Preoperative (A and C) and postoperative (B and D) photographs show that aesthetic appearance without G3 or G4 recurrence is achieved by amniotic membrane transplantation alone in an eye with sufficient residual conjunctiva (RC) (33.8 mm) and a high residual to horizontal (RH) ratio (0.87) (A and B, patient 3) and an eye without sufficient RC (16.2 mm) and a low RH ratio (0.45) (C and D, patient 4). In an eye with severe symblepharon, conjunctival scar, RC of 0, and D3 diplopia before surgery (E, patient 5), the same surgery results in no recurrence but a depressed hollow space in the caruncle area (F), as evidenced by the pooling of fluorescein solution (G) and incomplete eyelid closure (H, marked by bracket).
Collectively, 30 of 32 eyes (94%) achieved total success without recurrence and diplopia for a mean follow-up of 27.5 months. A C1 caruncle was achieved in 17 of 21 eyes (81%) that had flattened caruncles before surgery. The RC for those 23 patients successfully treated with AM transplantation alone was 27.8 (10.1) mm, which was significantly longer than for those 6 patients unsuccessfully treated with AM transplantation alone (13.1 [11.4] mm, P = .007) and those 8 successfully treated eyes that required additional CA or OMG (10.9 [10.4] mm, P = .001). No difference was found in RC between the last 2 groups (P = .30). Persistent inflammation at 4.4 (2.4) weeks was noted in the adjacent host conjunctiva or caruncle in 21 eyes (66%), among which 19 eyes (90%) received subconjunctival injections of triamcinolone acetonide, resulting in complete resolution in 16 eyes (84%). Two eyes developed granuloma pyogenicum (6%), which resolved in 1 eye (patient 17) after frequent topical corticosteroid drops; 1 eye (patient 23) eventually progressed to corneal recurrence.

The grading proposed by Tan et al\(^1\) is clinically useful for primary pterygia but was not suitable for recurrent pterygia because episcleral vessels were not visible in most of the 32 eyes (Figure 4). However, the caruncle grading was significantly correlated with preoperative binocular diplopia, RC, and the RH ratio. Furthermore, the caruncle grading also correlated well with the overall success of achieving a normal caruncle without recurrence and diplopia. Thus, the extent of fibrovascular growth is also reflected by cicatricial traction that flattens the caruncle, obliterates the semilunar fold, and results in short RC and diplopia. Future studies are needed to determine whether the caruncle grading can also refine the grading of primary pterygia. The corneal (G4) recurrence rates vary from 0% to 82.4% in all reported studies of recurrent pterygia (Table 3). It is understandable why bare sclera with or without mitomycin C has high recurrence rates from 19.2%\(^3\) to 82.4%.\(^1\) However, thorough removal of the fibrovascular tissue\(^5,6\) together with CA\(^1,4,5,0,10\) or AM\(^0,11\) to cover bare sclera still results in variable recurrence rates (ie, 0%\(^7\) to 33.3%\(^10\) for CA and 9.5%\(^6\) to 52.6%\(^11\) for AM transplantation) (Table 3). This peculiar variable outcome made us search for a better surgical approach. Compared with all reported studies, our surgical technique had the following 2 major differences. First, knowing RC could influence the surgical outcome, we “recessed” but did not “resect” the recurrent tissue. Without any tissue being resected, the gap shown between the conjunctiva and the underlying Tenon capsule was genuine and found ubiquitous in all eyes. Through the gap, fibrovascular cicatrix emanated and adhered to bare sclera, contributing to recurrence and diplopia. Second, we sealed the gap in all eyes. The use of AS in symblepharon lysis\(^23\) was first adopted, resulting in a high success of no recurrence in 10 eyes. Taking advantage of the availability of FG, we subsequently sealed the gap by FG/AS but found the overall result was significantly worse than with AS. This result suggested that ensuing fibrinolysis did not keep the gap sealed long enough to withstand emanation of fibrovascular tissue. That was why RS was used to seal the gap and found to be effective in restoring a normal caruncle because of the natural tendency of the Tenon capsule to retract posteriorly (Figure 1C and F).

Mitomycin C was used in 7 eyes in the AS group, 6 eyes in the AS/FG group, and 1 eye in the RS group (ie, relatively more in the AS/FG group). Because the recurrence rate was significantly higher in the AS/FG group, in which removal of fibrovascular tissue was not as thorough as in the AS group, we believe that mitomycin C alone is not sufficient to counteract recurrence, and an effective sealing (ie, thorough removal with AS or RS) may avoid mitomycin C use in recurrent pterygia. Per-
sistent inflammation at 4.4 (2.4) weeks was noted in the adjacent host conjunctiva or caruncle in 21 eyes (66%), among which 19 eyes (90%) received subconjunctival injections of triamcinolone, resulting in complete resolution in 16 eyes (84%). Previously, one of us reported that such persistent conjunctival inflammation occurred in 11 of 27 eyes (41%) with primary pterygia and significantly more often in eyes receiving sutures than FG and that 7 of these 11 eyes resulted in complete resolution after administration of subconjunctival triamcino-

Table 3. Literature Summary of Recurrent Pterygium Studies

<table>
<thead>
<tr>
<th>Source</th>
<th>Technique</th>
<th>Eyes, No.</th>
<th>Mean (SD) No. of Prior Operations/Maximum</th>
<th>Mean (SD) FU, mo</th>
<th>Minimal FU, mo</th>
<th>Recurrence, % (Grade)</th>
<th>Diplopia, % Pre/Post</th>
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<td>Tan et al,1 1997</td>
<td>BS</td>
<td>17</td>
<td>13.2 (5.9)</td>
<td>1</td>
<td>15.4 (G3)/19.2</td>
<td>82.4 (G4)</td>
<td></td>
</tr>
<tr>
<td>Cheng et al,21 2001</td>
<td>BS and mitomycin C</td>
<td>26</td>
<td>29.9 (3.9)</td>
<td>12</td>
<td></td>
<td></td>
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<tr>
<td>Kenyon et al,9 1985</td>
<td>CA</td>
<td>41</td>
<td>22.6 (16.6)</td>
<td>NA</td>
<td>7.3 (G4)</td>
<td></td>
<td>34.1/0</td>
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<tr>
<td>Prabhasavat et al,4 1997</td>
<td>CA</td>
<td>41</td>
<td>21.1 (19.1)</td>
<td>3</td>
<td>15.9 (G3)/9.0 (G4)</td>
<td></td>
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<tr>
<td>Tan et al,1 1997</td>
<td>CA</td>
<td>17</td>
<td>13.2</td>
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<td>Al Fayez,10 2002</td>
<td>CA</td>
<td>12</td>
<td>50.0</td>
<td>36</td>
<td>33.3 (G4)</td>
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<td>Luanratanakorn et al,11 2006</td>
<td>CA</td>
<td>14</td>
<td>6.0</td>
<td>6</td>
<td>21.4 (G3)/21.4 (G4)</td>
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<td>Hirst,5 2009</td>
<td>CA</td>
<td>111</td>
<td>17.1 (9.7)</td>
<td>0.03</td>
<td>0 (G4)</td>
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<td>8.1/0</td>
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<td>CA and mitomycin C</td>
<td>32</td>
<td>40.9 (19.1)</td>
<td>12</td>
<td>18.8 (G3)/6.3 (G4)</td>
<td></td>
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<tr>
<td>Solomon et al,6 2001</td>
<td>AMT</td>
<td>21</td>
<td>14.3 (4.9)</td>
<td>6.3</td>
<td>19.0 (G3)/9.5 (G4)</td>
<td>33.3/4.8</td>
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<tr>
<td>Ma et al,7 2005</td>
<td>AMT</td>
<td>48</td>
<td>28.6 (22.7)</td>
<td>12</td>
<td>12.5 (G3)/12.5 (G4)</td>
<td>12.5/2.1</td>
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</tr>
<tr>
<td>Luanratanakorn et al,11 2006</td>
<td>AMT</td>
<td>19</td>
<td>6.0</td>
<td>6</td>
<td>21.1 (G3)/52.6 (G4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ma et al,7 2005</td>
<td>AMT and mitomycin C</td>
<td>47</td>
<td>27.9 (20.2)</td>
<td>12</td>
<td>8.5 (G3)/12.8 (G4)</td>
<td>4.3/0</td>
<td></td>
</tr>
<tr>
<td>Fallah et al,32 2008</td>
<td>AMT and mitomycin C</td>
<td>20</td>
<td>12.6 (3.2)</td>
<td>6</td>
<td>20.0 (G4)</td>
<td></td>
<td>15/0</td>
</tr>
<tr>
<td>Present study</td>
<td>AMT, sealing the gap, and CA or OMG</td>
<td>32</td>
<td>27.5 (20.5)</td>
<td>8</td>
<td>0 (G3)/3.1 (G4)</td>
<td></td>
<td>81.3/3.1</td>
</tr>
</tbody>
</table>

Abbreviations: AMT, amniotic membrane transplantation; BS, bare sclera; CA, conjunctival autograft; FU, follow-up; G (3-4), grading of pterygium recurrence; NA, not available, OMG, oral mucosal graft; pre/post, preoperative/postoperative.
lone. These results suggest that postoperative persistent inflammation was more prevalent in recurrent pterygia and that subconjunctival triamcinolone is an effective postoperative adjunctive measure to combat recurrence. Because subconjunctival triamcinolone was given in 5 eyes in the AS group, 10 eyes in the AS/FG group, and 4 eyes in the RS group (ie, significantly more in the AS/FG group), we also believe that AS/FG is not as effective as the other 2 treatments in controlling postoperative inflammation that may lead to recurrence and that FG use to seal the gap is not effective in recurrent pterygia.

In 29 eyes, in which the gap was sealed by AS (n = 9), FG/AS (n = 11), and RS (n = 9), AM transplantation alone was successful in 23 eyes with RC of 27.8 (10.1) mm, which was significantly longer than that of the 6 eyes in which treatment failed (13.1 [11.4] mm, P = .007). Without sufficient RC, epithelial healing came only from superior and inferior fornices, and delayed epithelization might lead to persistent inflammation and scarring, triggering recurrence when the gap is not sealed. This finding explained why additional CA or OMG was necessary and achieved 100% success in 8 eyes with a short RC of 10.9 (10.4) mm, which was also significantly less than those eyes successfully treated by AM transplantation alone (P = .001). Four of these 8 eyes had previously undergone failed surgery (1 from the AS group, 2 from the FG/AS group, and 1 from the RS group), strongly suggesting the necessity of additional transplantation of CA or OMG in eyes with an RC less than 20 mm or an RH ratio less than 0.6 (95% reference value).

As a group, our surgical techniques reduced the recurrence rate to 3.1%, which was more favorable than the 20% to 73.7% reported using AM transplantation11,32 and the 7.3% to 42.8% reported using CA.5,11 Recurrent pterygia in our cases was more severe than that reported previously, including 2 studies reporting zero recurrence (Table 3). Binocular diplopia was present in 81% of our 32 eyes but was absent in all 17 eyes described by Tan et al11 and was present in 8% of 111 eyes described by Hirst.5 More than 2 prior operations were performed in 62% of our 32 eyes, but only 1 prior operation was performed in 71% of 111 eyes by Hirst.3 We wonder whether the zero recurrence rate achieved by the latter may also be attributed to sealing of the gap by a 9-0 Vicryl RS at the nasal limbus.

Although UV irradiation plus genetic and environmental factors contribute to the development of pterygia, the exact underlying cause of pterygia remains largely elusive. Our findings highlight the importance of the fibrovascular tissue emanating from the caruncle in contributing to pterygium growth and demonstrate the effectiveness of sealing the gap in combating pterygial recurrences. We believe that sealing of the gap is an important step in creating a strong barrier for preventing recurrence, restoring caruncle morphological characteristics, and regaining full ocular motility in multirecurrent pterygia. We speculate that failure of sealing such a gap explains highly variable recurrence rates by different surgical approaches. Furthermore, sealing of the gap may also be applied to primary pterygium and other cicatricial diseases manifesting the same pathologic change.

A prospective, randomized, controlled, clinical trial in primary pterygium using RS to seal the gap is under way to test this hypothesis.

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Correspondence: Scheller C. G. Tseng, MD, PhD, Ocular Surface Center and Ocular Surface Research & Education Foundation, 7000 SW 97th Ave, Ste 213, Miami, FL 33173 (stseg@ocularsurfacere.com).

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REFERENCES


