Outcomes of Bleb Repair for Delayed Bleb Leaks and Sweating Blebs

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Purpose: To report the outcomes of bleb repair for delayed onset leaking blebs and sweating blebs following glaucoma filtering surgery.

Materials and Methods: Medical records of 76 eyes of 76 subjects that underwent bleb repair for either leaking bleb or sweating bleb between 1990 and 2015 were reviewed. Complete success was resolution of bleb leak and or hypotony with intraocular pressure ≥5 and ≤21 mm Hg with no antiglaucoma medication.

Results: There were 45 eyes with leaking bleb and 31 eyes with sweating bleb that underwent bleb repair by either conjunctival autograft or conjunctival advancement (P = 0.11). Before bleb repair, complications like blebitis and hypotony maculopathy were significantly higher in sweating bleb group (13/31) compared with leaking bleb group (5/45) (P = 0.002). Median follow-up after bleb repair was >2 years in both groups (P = 0.69). After repair, eyes in leaking bleb group had higher immediate (P = 0.01) and long-term intraocular pressure elevation (P = 0.006) compared with sweating bleb group. Complete success probability in sweating bleb group was significantly better (88%, 78%, and 71%) compared with leaking bleb group (54%, 45%, and 40%) at 1, 3, and 6 years, respectively (P = 0.01). One eye in each group had blebitis, 2 eyes in leaking bleb group and 1 eye in sweating bleb group needed repeat glaucoma intervention.

Conclusions: Higher complication rate before bleb repair in eyes with sweating bleb warrants early bleb repair. Bleb repair helped retain bleb function in majority of the eyes with sweating blebs, strengthening our recommendation.

Key Words: late leaking blebs, conjunctival advancement, conjunctival autograft, bleb leak, bleb repair, sweating blebs, post trabeculectomy complication, bleb-related complication (J Glaucoma 2018;27:33-40)

Bleb leak is a known complication following glaucoma filtering surgery (GFS), both in the early and late postoperative period. Thin ischemic blebs may leak months or years later and are known as delayed or late leaking blebs. Bleb leaks can have high flow leaks that are Siedel's positive or can be low flow pin-point leaks or may present with bleb sweating or transconjunctival ooze. These complications are more common with full thickness procedures and are seen increasingly with adjunctive antimetabolite augmented trabeculectomies. Chronic or late bleb leaks are more commonly seen with thin cystic and avascular blebs (5.2% to 6%) compared with thick walled blebs (1.1% to 1.3%).

Leaking blebs precipitate the eyes to complications, like hypotony maculopathy, choroidal detachment, shallow or flat anterior chamber (AC), corneal decompensation, cataract formation, and can be a risk factor for bleb failure too.

Bleb leaks and avascular blebs are more prone to serious vision threatening complications like blebitis and bleb-related endophthalmitis. Treatment of delayed leaking blebs is challenging and successful closure of the leak often requires surgical repair.

The two surgical procedures commonly used for bleb repair are free conjunctival autograft, and conjunctival advancement. The choice of bleb repair depends on the bleb characteristics.

Currently the indications for bleb repair are bleb dysesthesis, large sweating bleb with hypotony maculopathy, bleb leak, or blebitis. Various studies have evaluated outcomes of bleb repair in eyes with ≥1 of these complications. Although avascular blebs and sweating blebs are more prone to blebitis and hypotony maculopathy, and are clinical indications for bleb repair, the outcomes of bleb repair in these eyes with no obvious leak but with many of the associated complications has not been evaluated so far. Some of the objective is to evaluate the outcomes of bleb repair in eyes with delayed leaking blebs and nonleaking or sweating blebs using either conjunctival advancement or conjunctival autograft.

Materials and Methods

We retrospectively reviewed the medical records of all consecutive glaucoma patients who underwent bleb repair between 1990 and 2015 at our institute for a delayed onset leaking bleb or sweating bleb following a GFS. The Institutional review board of L.V. Prasad Eye Institute approved the study. Some of the patients in this study were also included in smaller case series published earlier.

We included eyes with late bleb leak with definite aqueous streaming in 1 group and those blebs with bleb sweating into another group. Patients with bleb leak within 3 months of GFS, those with obvious trauma causing bleb leak and those with <6 weeks follow-up were excluded from the study. Eyes that underwent bleb repair for dysesthetic blebs with no leak or hypotony or eyes that needed scleral patch graft during bleb repair were excluded.
The clinical details collected were: age, sex, type of glaucoma, date and type of the primary GFS, use of anti-fibrotics, interval between trabeculectomy and bleb leak or hypotony, bleb characteristics and anterior segment details, optic disc and retinal evaluation surgical technique of bleb repair, complications and their management, resurgeries if any, intraocular pressure (IOP), visual acuity (VA) and number of antiglaucoma medications before and after bleb repair.

Although the documentation of sweating bleb was not available in the records, we had good documentation with bleb drawings with details of the Seidel positivity and location of the leak. Presence of positive Seidel test (fluorescein dye washed away by the aqeous leaking from the bleb) constituted a “leaking bleb.” Increase in the fluorescence of the bleb area with no obvious aqueous streaming on the Seidel test as documented constituted a “sweating bleb.” These blebs had no conjunctival defect but had either staining or slow ooz of aqueous with hypotony. Hypotony was defined as IOP ≤ 5 mm Hg on 2 consecutive occasions.

Hypotony maculopathy was defined as hypotony with loss of ≥ 2 lines of VA in the presence of macular folds. Conservative treatment in the form of large diameter soft bandage contact lens (BCL) (15 to 20 mm) and topical aminoglycoside eye drops (to incite conjunctival inflammation and stimulate healing) were tried in a few patients before the surgical repair.

Type of surgical repair was surgeon’s discretion. However, the technique of repair was planned based on the nature and extent of the bleb leak, site of leak, and the health and mobility of the adjacent conjunctiva. Conjunctival advancement was preferred in the presence of a small avascular bleb or a small anterior leak (< 2 to 3 mm from the limbus) with surrounding healthy and mobile conjunctiva. In the presence of large avascular bleb or a small bleb with surrounding scarred conjunctiva, a conjunctival autograft was preferred. If the bleb wall was ischemic and unhealthy, it was excised, if there was a pinpoint area of leak with surrounding bleb which was functional and healthy, only the area of the leaking bleb was deepithelized and debrided and the conjunctival autograft or advancement planned. All surgeries were performed by one of the 6 glaucoma specialists (A.K.M., G.C.S., H.L.R., N.K.L., S.D., S.I.R.). All surgeries were performed under peribulbar anesthesia with 2% lidocaine and 0.5% bupivacaine. Superior rectus or corneal traction suture was applied as required during the surgery.

Surgical Procedure

Conjunctival Advancement

A fornix-based conjunctivo-tenon incision was made delineating the bleb, peritomy was carried out to free the adjacent conjunctiva to allow adequate anterior advancement. The anterior ischemic bleb was either debrided of the epithelium following a gentle cautery or was completely excised. The underlying sclera was examined for the presence of a defect with excess outflow, which was the cause of thin bleb, if the defect was noted it was sutured with 10/0 nylon (Ethicon, Somerville, NJ). The conjunctiva was then anteriorly advanced and sutured at the limbus ensuring a watertight closure with interrupted 10/0 nylon sutures.

Conjunctival Autograft

The dimensions of the bleb were measured using a calipers and an oversized conjunctival autograft (by 2 mm) was harvested from adjacent or inferior bulbar conjunctiva. Slightly oversized graft was planned to prevent traction on the wound edges and also to account for the postoperative tissue shrinkage and bleb elevation. After debriding the bleb wall or excising the avascular bleb, additional scleral sutures with 10/0 nylon were applied if an underlying scleral defect with excess leakage was noted. Maintaining the limbal orientation, the harvested conjunctiva was placed over the bleb area and anchored with interrupted 10/0 nylon sutures.

The standard postoperative regimen was followed, which was topical antibiotic and cycloplegic eye drops for 1 to 2 weeks with tapering dose of topical steroids for 4 to 5 weeks. Postoperative reviews were on day 1, weeks 1, 6, and 4 to 6 monthly thereafter.

The primary outcome measure was cumulative probability of success. Success was defined as complete in the presence of resolution of bleb leak or hypotony with IOP ≤ 5 and ≤ 21 mm Hg without any antiglaucoma medications and as qualified in the presence of resolution of bleb leak or hypotony with or without antiglaucoma medications for IOP control. Failure was defined as ≥ 1 of the following: (a) presence of persistent bleb leak, which required repeat surgery, (b) persistent hypotony (IOP < 5 mm Hg), or (c) IOP > 21 mm Hg despite medical treatment or need for repeat glaucoma surgery. We also looked at complete success at IOP cutoffs of ≥ 5 and ≤18 mm Hg and ≥ 5 and ≤ 16 mm Hg.

Statistical Analysis

Snellen VA measurements were converted to logarithm of minimum angle of resolution equivalents for the purpose of analysis. Descriptive statistics for continuous variables included mean and standard deviation (SD) for normally distributed variables and median, first quartile, and third quartile values for non-normally distributed variables. Normally distributed variables were compared using “t” test and non-normally distributed variables using the Wilcoxon ranksum test. Categorical variables were summarized as percentages and compared using χ2 test. The Kaplan-Meier survival analysis was used to assess cumulative probability of success. Statistical analyses were performed using commercial software (Stata version 11.0; Stata Corp., College Station, TX). A P-value of ≤ 0.05 was considered statistically significant.

RESULTS

Demographic Data, Preoperative Characteristics and Surgical Details

A total of 116 eyes underwent bleb repair for late leaking blebs from the year 1990 to 2015 at our Institute. Bleb repair for overhanging blebs (dysesthetic blebs) or those eyes requiring scleral patch graft during bleb repair together constituted 40 eyes, which were excluded. We included 76 eyes of 76 subjects that underwent bleb repair for either late leaking bleb or nonleaking sweating bleb. The demographic, preoperative characteristics of the study subjects are given in Table1.

Among the 76 eyes that underwent bleb repair, the indication for bleb repair was leaking bleb in 45 eyes and sweating bleb in 31 eyes. The median age of subjects was similar in the 2 groups (P = 0.17). Among the 76 eyes that underwent bleb repair, 29 eyes had primary surgery at our institute and the other 47 surgeries were performed elsewhere and referred to us with the complication. More than
TABLE 1. Demographic and Preoperative Characteristics of Bleb Repair Cohort

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Bleb Leak (N = 45)</th>
<th>Sweating Bleb (N = 31)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (IQR) (y)</td>
<td>52 (32, 60)</td>
<td>58 (37, 64)</td>
<td>0.17*</td>
</tr>
<tr>
<td>Sex (male:female)</td>
<td>36:9</td>
<td>21:10</td>
<td>0.2†</td>
</tr>
<tr>
<td>Type of glaucoma</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JOAG</td>
<td>4</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>POAG</td>
<td>7</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>PACG</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Secondary</td>
<td>4</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>NA</td>
<td>12</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Previous glaucoma surgery (no. eyes) [n (%)]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iridencilis</td>
<td>2 (4.4)</td>
<td>1 (3.2)</td>
<td>0.5†</td>
</tr>
<tr>
<td>Trabeculectomy</td>
<td>29 (64.4)</td>
<td>17 (55)</td>
<td></td>
</tr>
<tr>
<td>Trabeculectomy with MMC</td>
<td>13 (29)</td>
<td>10 (32.2)</td>
<td></td>
</tr>
<tr>
<td>Cataract</td>
<td>1 (2.2)</td>
<td>3 (9.6)</td>
<td></td>
</tr>
<tr>
<td>Indication for surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bleb leak</td>
<td>45</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Hypotonymaculopathy</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Shallow AC with corneal edema</td>
<td>0</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Prior blebitis</td>
<td>3</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Median preoperative Log MAR visual acuity</td>
<td>0.3 (0.1, 0.7)</td>
<td>0.6 (0.3, 1.0)</td>
<td>0.11</td>
</tr>
<tr>
<td>Median preoperative IOP (mm Hg)</td>
<td>7 (4, 10)</td>
<td>10 (4, 12)</td>
<td>0.27</td>
</tr>
<tr>
<td>Median duration from trabeculectomy to bleb repair (mo)</td>
<td>51.7 (39.7, 95.9)</td>
<td>116.4 (38, 201)</td>
<td>0.18*</td>
</tr>
<tr>
<td>Type of bleb repair [n (%)]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conjunctival advancement</td>
<td>18 (40)</td>
<td>7 (23)</td>
<td>0.11</td>
</tr>
<tr>
<td>Conjunctival autograft</td>
<td>27 (60)</td>
<td>24 (77)</td>
<td></td>
</tr>
</tbody>
</table>

*Represents rank sum test.
†Represents χ² test.
‡AC indicates anterior chamber; IOP, intraocular pressure; IQR, interquartile range; JOAG, juvenile open-angle glaucoma; Log MAR, logarithm of minimal angle of resolution; MMC, mitomycin C; NA, etiology was not available; PACG, primary angle closure glaucoma; POAG, primary open angle glaucoma.

Half of the eyes had trabeculectomy without antimetabolites as primary glaucoma surgery (29 eyes in leaking bleb group and 17 eyes in sweating bleb group) and one-third had trabeculectomy with mitomycin C (MMC) (13 eyes in leaking bleb group and 10 eyes in sweating bleb group). In 7 eyes there was no information on the use of antimetabolites (operated elsewhere).

The type of glaucoma was similar in both the groups.

In the sweating bleb group, 4 eyes had hypotonymaculopathy, 6 eyes had previous blebitis, and 3 eyes had shallow AC with corneal edema. In the leaking bleb group, 2 eyes had hypotonymaculopathy and 3 eyes had previous blebitis. Bleb-related or hypotonymaculopathy-related complications were seen more frequently in sweating bleb group compared with leaking bleb group (42% vs. 11%; P = 0.002). Median duration from trabeculectomy to bleb repair in eyes with sweating bleb was more than twice the duration compared with eyes with leaking bleb, (116.4 vs. 51.7 mo), however this difference did not reach statistical significance (P = 0.18).

Median preoperative VA was better in eyes with leaking bleb group compared with those with sweating blebs (0.3 vs. 0.6), although this was not statistically significant (P = 0.11), was clinically significant. This difference was apparent even after excluding eyes with bleb-related complications, in eyes with no preexisting complications, the median VA was 0.25 (0.1, 0.7) in the leaking bleb group and was 0.6 (0.3, 0.8) in the sweating bleb group.

Bleb repair was either performed with conjunctival advancement or conjunctival autograft. Both groups had more eyes managed with conjunctival autograft compared with conjunctival advancement. Five eyes had scleral flap suturing, 4 eyes with leaking bleb, and 1 eye with sweating bleb had a scleral suture during bleb repair. Among these eyes that underwent scleral flap suturing in the leaking bleb group, 3 eyes had bleb repair with conjunctival advancement and 1 eye with conjunctival autograft. The 1 eye in sweating bleb group that underwent scleral flap suturing was repaired by conjunctival advancement. The IOP increased in all eyes following bleb repair with scleral flap suturing. The increase in IOP in eyes with flap suture was by a median of 9 mm Hg (interquartile range: 5.5, 25.5 mm Hg), however in eyes with no scleral flap suture the median increase postbleb repair was 6 mm Hg (interquartile range: 2, 9). Although the increase in IOP was higher in the eyes with scleral flap suture, this was not statistically significant due to small sample size. There was a vitreous tag noted intraoperatively which was cleared with an automated vitrector in an eye with bleb leak that underwent conjunctival autograft.

Three eyes in sweating bleb group, which had preexisting corneal edema had worsening of corneal edema and decompensation needing intervention. Although this was not a complication of bleb repair, long-standing shallow AC in these eyes with sweating blebs possibly resulted in this complication. Among these 3 eyes, 1 eye underwent penetrating keratoplasty, 1 eye underwent anterior stromal puncture and the third patient was advised keratoplasty but was lost to follow-up.

Postoperative Characteristics

Table 2 shows the postoperative characteristics and complications. The median postoperative VA was 0.2 (0.1, 0.6) in eyes treated for leaking blebs and was 0.4 (0.1, 1.1) in eyes treated for sweating blebs (P = 0.31). VA change (by logarithm of minimum angle of resolution) postbleb repair in eyes with sweating blebs was 0.09 (−0.2, 0.48) and in eyes with leaking blebs was 0 (−0.1, 0.18), the change in VA was not different between the 2 groups, P = 0.38. In eyes with sweating bleb, 14 eyes had no change in VA, 10 eyes had improvement of > 2 lines and 7 eyes had ≥ 2 lines deterioration. In eyes with bleb leak, 25 eyes had no change in VA, 10 eyes had ≥ 2 lines of improvement in VA, and 10 eyes had ≥ 2 lines deterioration. The reasons for decrease in vision in sweating bleb group were: 2 eyes due to corneal edema, 1 eye due to blebitis, and 4 eyes due to cataract. In the bleb leak group: 2 eyes due to high IOP and worsening of glaucoma and 8 eyes due to cataract.

Early Post–bleb Repair Complications

In the leaking bleb group, postbleb repair, 4 eyes had persistent leak, 2 of these resolved with use of BCL, and 2 eyes required resuturing. In the eyes with sweating blebs, postbleb repair, 1 eye had persistent leak with hypotony that
resolved with BCL. Early IOP elevation postbleb repair was significantly higher in leaking bleb group (9 eyes) compared with sweating bleb group (2 eyes) \( (P < 0.01) \).

### Late Post–bleb Repair Complications

The median follow-up postbleb repair was > 2 years in both the groups. During the follow-up, more number of eyes (40% eyes) in the leaking bleb group needed antiglaucoma medications for IOP control compared with (19% eyes) those with sweating blebs \( (P = 0.06) \). Two eyes in the leaking bleb group needed repeat glaucoma intervention for IOP control (1 repeat trabeculectomy with MMC after 2 y and 1 transscleral cyclophotocoagulation after 1 mo of bleb repair) and 1 eye in sweating bleb group needed repeat trabeculectomy 4 months after bleb repair.

One eye in leaking bleb group and 2 eyes in sweating bleb group had persistent hypotony, without hypotony maculopathy. As all the 3 eyes had VA improvement both for distance and near (better than 20/40 for distance and N6 for near) no further intervention was needed. Postbleb repair, 7 eyes in leaking bleb group (15.5%) and 8 eyes in sweating bleb group (25.8%) developed visually significant cataract. “Visually significant cataract” was when the clinician attributed the decrease in vision to cataract and there was no other cause for decreased VA.

One eye in each group developed overhanging/dysesthetic bleb. One eye in leaking bleb group had blebitis and 1 eye in sweating bleb group had blebitis with endophthalmitis. The eye in sweating bleb group developed blebitis and endophthalmitis 3 months after repeat glaucoma repair. This eye needed bleb excision with pars plana vitrectomy and intraocular antibiotics. The infection resolved and vision improved to 20/200 with IOP of 11 mm Hg with no antiglaucoma medications until last follow-up (at 38.3 mo). The eye in the bleb leak group developed blebitis 3 months following conjunctival autograft. This eye resolved with intensive medical treatment and did not require any surgical intervention.

### Kaplan-Meier Survival Probability

Following bleb repair, complete success was seen in 54% at 1 year, 45% at 3 years, and 40% at 6 years in bleb leak group as compared with 88% at 1 year, 78% at 3 years, and 71% at 6 years in the sweating bleb group (Fig. 1A); the difference was statistically significant at all time points \( (P = 0.01) \). When an IOP cutoff of 18 was considered, in sweating bleb group, the probability of complete success was 88% at 1 year, 77.9% at 2 years, 63.5% at 6 years. In bleb leak group, the survival was 59.4% at 1 year and 2 years, and 41.4% at 6 years \( (P = 0.02) \) (Fig. 1B). When an IOP cutoff of 16 was considered, in sweating bleb group, the probability of complete success was 83% at 1 year, 74% at 2 years, 60% at 5 years, and 45% at 6 years and in bleb leak group was 57.7% at 1 year and 2 years and 40% at 5 and 6 years \( (P = 0.04) \) (Fig. 1C).

The qualified success probability was 94.6% at 1 year in bleb leak group and 100% in sweating bleb group, which decreased to 84.7% and 82% at 6 years in the bleb leak group and sweating bleb group, respectively (Fig. 2). The qualified success probability was similar between the 2 groups \( (P = 0.60) \).

### DISCUSSION

Intuitively, leaking blebs are likely to be associated with higher rates of bleb-related and hypotony-related complications. However, our data shows that the complications like blebitis, hypotony maculopathy, and shallow AC with corneal edema were more common in eyes with sweating blebs compared with leaking blebs (42% vs. 11%, \( P = 0.002 \)). The eyes with sweating blebs also had worse VA compared with the eyes with leaking blebs. This difference could not be explained by the preoperative factors.
like type of glaucoma or use of antimetabolites (which was similar between the 2 groups). The 1 parameter that was significantly different was the, longer duration from primary glaucoma surgery to bleb repair in the sweating bleb group. It is possible that the longer the presence of avascular and sweating blebs, the higher the chance of bleb-related complications like hypotony with associated maculopathy, cataract, and corneal edema. The longer duration before diagnosis and the greater incidence of complications in the sweating bleb group may also be a result of greater difficulty in diagnosing sweating blebs, which is subtle compared with a frank leak. Ocular complications like hypotony maculopathy and blebitis are definite indications for bleb repair in eyes with delayed leaking blebs or sweating blebs.\textsuperscript{14,17,21,23} However, uncommon indications for bleb repair are thin cystic or sweating blebs without ocular complications.\textsuperscript{20} In our study evaluating the outcomes of bleb repair for delayed bleb leaks and sweating blebs, the complete success probability was significantly better (88\% vs. 54\% at 1 y and 71\% vs. 40\% at 6 y) in the sweating bleb group compared with the leaking bleb group, respectively ($P=0.01$). Significant difference in the survival probabilities of both the groups was noted even when IOP cutoff of 16 and 18 mm Hg were considered. The possible reason for the significant difference in the success rates between the 2 groups could be the difference in the bleb function between the 2 groups. It is possible that in eyes with frank bleb leak, the blebs are flat with less subconjunctival aqueous, predisposing them to subconjunctival fibrosis. In these eyes when the bleb leak is repaired, the IOP may elevate significantly, often needing...
medications or surgery for IOP control. In contrast, in eyes with sweating blebs, the blebs are cystic and elevated and functional. Therefore, when repaired with adequate precautions; the bleb function would be preserved providing better IOP control. From our results, we would consider leaking bleb a strong risk factor for failure after bleb repair. The technique of bleb repair is unlikely to have contributed to the difference in success rates of the 2 groups as similar number of eyes in both the groups underwent bleb repair with conjunctival advancement and conjunctival autograft. The reported overall success rates of bleb repair with various techniques were 80% to 86% at 1 year, which decreased to 50% at 5 years.\(^{17,20}\) The variability in the outcomes across studies is due to the differences in the indications, type of intervention, definition of success, and the follow-up duration. There is limited literature comparing the outcomes of bleb repair in leaking and nonleaking blebs. In the study by Catoira and colleagues, following bleb repair with conjunctival advancement, leaking blebs showed 47% success (8/17 eyes) versus 80% success (8/10 eyes) in eyes with nonleaking cystic blebs with hypotony, similar to our results. Although they did not compare the 2 indications in their study, their results clearly show that the eyes with leaking blebs had higher tendency to scar and fail and required antiglaucoma medications for IOP control compared with the eyes with nonleaking blebs. In our study, bleb leak closure was achieved in 95% eyes in the leaking bleb group. Most studies have reported similar success rates ranging from 80% to 100% for bleb leak closure.\(^{17,19-21,23}\) The aim of bleb repair is not only closure of bleb leak or resolution of hypotony, but also to preserve the bleb function. Early postoperative increase in IOP is an expected complication following bleb repair as was noted in 2% to 13.7% eyes in previous reports.\(^{20,23,25}\) This complication was seen in majority of eyes that underwent scleral flap tightening in Radhakrishnan et al study.\(^{20}\) The number of eyes with elevated IOP was higher in the leaking bleb group [9 eyes, 20%; 95% confidence interval (CI): 9.6-34.6] compared with sweating bleb group (2 eyes, 6.5%; 95% CI: 0.8-21.4%) at 1 month. However, in our series, although the IOP elevation postbleb repair with additional flap sutures was high, this did not contribute to long-term IOP elevation in all the eyes with flap suture. Two of 5 eyes (1 of 4 eyes in leaking bleb group and 1 of 2 eyes in sweating bleb group) that had scleral flap suture during bleb repair needed antiglaucoma medications for IOP control. In contrast, 19 of 71 eyes without the scleral flap suture had raised IOP. The difference was not statistically significant due to small sample that had flap sutures.

Early bleb leaks are reported in 10.7% to 46% eyes following bleb repair,\(^{14,21,23}\) and persistent hypotony or recurrent bleb leaks are reported in 3.5% to 8% eyes.\(^{17,21,23}\) Persistent or recurrent bleb leaks following bleb repair can occur secondary to flap retraction or leakage between the sutures. This can be avoided with slightly oversized graft to achieve traction free conjunctival closure. We had 2 eyes in the leaking bleb group with persistent leak needing resuturing. There were no recurrent bleb leaks noted in both the groups. In our series, 3 eyes had persistent hypotony (3.9% eyes, 2 eyes in sweating bleb group and 1 eye in leaking bleb group), however all 3 eyes had good visual recovery, hence no further intervention was attempted. If these eyes were considered successful as in Radhakrishnan et al\(^ {20}\) study (who considered resolution of hypotony either by IOP criteria of > 5 mm Hg or by visual recovery despite not satisfying the IOP criteria) our success rates would increase.

Long-term IOP elevation needing antiglaucoma medications for IOP control or repeat glaucoma surgery following bleb repair is reported in 12% to 50% of the eyes.\(^{13,17,20,23}\) In our study, postbleb repair, long-term antiglaucoma medications was needed in 18 (40%; 95% CI: 19.4-58.5%) eyes in the leaking bleb group compared with 6 (14.3%; 95% CI: 7.5-37.5) in the sweating bleb group (\(P = 0.06\)). Repeat glaucoma surgery was needed in 4.2% eyes in leaking bleb group and 3.2% eyes in sweating bleb group.

Blebitis and endophthalmitis are complications that can occur few months to many years after bleb repair. Radhakrishnan et al\(^ {20}\) reported blebitis in 5% of cases (9/177) after bleb revision surgery with a mean interval between the revision surgery and diagnosis of blebitis of 3.0 ± 2.4 years. Panday and colleagues in a series of 58 eyes with bleb repair reported 1 case of recurrent blebitis with endophthalmitis 6 months following bleb repair. This eye had prior episode of blebitis with endophthalmitis before bleb repair and resulted in phthisis despite treatment with vitrectomy and intravitreal antibiotics.\(^ {21}\) Two eyes in our series developed blebitis in the late postoperative period. One eye developed blebitis after 3 months of bleb revision, which resolved with intensive topical antibiotics. The other eye developed blebitis and endophthalmitis after 3 years of bleb revision and required bleb excision with vitrectomy and intravitreal antibiotics. Both the eyes maintained stable vision and well-controlled IOP and both these eyes did not have prior blebitis.

Bleb dysesthesia following bleb repair is a rare complication. Following bleb repair, 5/177 eyes had bleb dysesthesia in a study by Radhakrishnan et al\(^ {20}\) and 3/30 eyes in Catoira et al\(^ {11}\) series had bleb dysesthesia. In our series, 1 eye in each group had overhanging bleb. Apart from the discomfort the dysesthetic blebs cause, these eyes are also...
prone for complications like blebitis as was seen in one of the eyes in our series.

Visually significant cataract was noted in 15.5% and 25.8% eyes in the 2 groups after bleb repair. This could be related to chronic hypotony, shallow AC, low-grade inflammation, and possible postoperative steroid use.26,27 Although corneal complications are rare following bleb repair, preexisting ocular condition and anterior segment status would contribute to corneal edema and decompensation. In our series, 3 eyes in sweating bleb group had worsening of preexisting corneal edema needing keratoplasty. All the 3 eyes had hypotony with shallow AC before bleb repair that resulted in this complication. It is well known that shallow AC, hypotony maculopathy, and corneal complications are more common in eyes with bleb leak. However, in our study we found these complications were more in eyes with sweating blebs. It is likely that the eyes with obvious leak are intervened and treated early as opposed to the ones with sweating blebs. It is also possible that these eyes with sweating blebs were leaking chronically and patients presented late or the diagnosis and intervention were delayed. It is also likely that these eyes had intermittent leaks and the AC shallowed and the leak sealed, hence could not be identified. The longer duration between primary surgery and bleb repair in the sweating bleb group, increased preoperative complications and lesser VA in these eyes, point towards greater complication rate in this group.

Significant number of eyes in our cohort that had bleb repair had simple trabeculectomy without antimetabolite use (64% in bleb leak group and 55% in sweating bleb group) as opposed to those with MMC use (29% in bleb leak group and 32% in sweating bleb group). Over the past 25 years there has been significant change in the surgical techniques of trabeculectomy in addition to the use of intraoperative MMC. The earlier technique of trabeculectomy was either limbal-based or a small area fornix-based trabeculectomy, which resulted in localized anterior blebs often thin and cystic. Therefore, in our cohort eyes with simple trabeculectomy had greater bleb-related complications needing bleb repair. We started the use of MMC in primary surgeries with wide-area dissection and wide-area application of MMC. The concentration and duration of MMC was maintained at 0.04% for 2 minutes. There surgical modifications possibly contributed to lesser bleb-related complications needing bleb repair in eyes with MMC augmented trabeculectomy.

The limitations of our study are inherent to the retrospective nature. Bleb function before the development of the bleb leak, duration of bleb leak, and bleb morphology are important factors that could determine the functional success of filtering surgery after a bleb repair. However, these details were not available in our study. There were 2 techniques of bleb repair performed in our study, the conjunctival autograft and conjunctival advancement; the choice of which was at surgeons’ discretion. The difference in the technique of bleb repair could have influenced our results, however on subgroup analysis, the technique of bleb repair did not contribute to the difference in the success rates of bleb repair in both the groups. There were multiple surgeons who performed the surgeries, which could have influenced our results. However, all the surgeons were fellowship trained glaucoma specialists and the surgical technique followed was similar, hence unlikely to have contributed to the difference in the surgical success.

In view of higher prevalence of preoperative complications in the sweating bleb group and better bleb survival following bleb repair, we recommend early intervention in eyes with sweating blebs, rather than wait for an obvious bleb leak or a complication to intervene. The importance of careful examination to diagnose sweating blebs cannot be overemphasized.

REFERENCES


