SCIENTIFIC REPORT

Frequency of bleb manipulations after trabeculectomy surgery

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Br J Ophthalmol 2007;**91**:873–877. doi: 10.1136/bjo.2006.109835

Aim: To quantify the type and frequency of postoperative bleb manipulations undertaken after modern glaucoma surgery.

Methods: Bleb manipulations were recorded after trabeculectomy surgery on 119 consecutive patients with at least 1 year of follow-up. The type of intervention and time after surgery were recorded. Statistical analysis identified success rates at various intraocular pressure (IOP) cut-off definitions and identified factors that increased the risk for bleb manipulation.

Results: In all, 78.2% of trabeculectomies were followed by some form of bleb manipulation. Almost 49% of blebs underwent massage and a similar number required at least one suture removal, 31.1% required at least one 5-fluorouracil (5-FU) injection and 25.2% required at least one needling and 5-FU injection. The median time to the first intervention for massage, suture removal, 5-FU injection, and needling and 5-FU injection were 1, 14, 14 and 43 days, respectively. IOP measurements were higher at all follow-up time points in the intervention group. Failure to achieve specific IOP target pressures was also generally poorer in the 5-FU, and needling and 5-FU intervention groups.

Conclusions: Postoperative intervention is a frequent occurrence after modern glaucoma surgery. This requires intensive postoperative follow-up and is a labour-intensive undertaking. Despite interventions in our group of patients, IOP in the intervention group was always higher than in the group that required no intervention.

Modern trabeculectomy surgery has evolved significantly over the past 15 years.^{1,2} The introduction of intraoperative^{3–5} and postoperative^{4–6} antimetabolite application for the manipulation of wound healing have greatly enhanced the success rates of surgery. The use of antimetabolites as a surgical adjunct is now well established, particularly for repeat surgery.²

In addition to the use of antimetabolites during and after surgery for modulation of healing, there have also been developments in the manipulation of flow resistance after surgery. Traditionally, the flap was closed with fixed sutures, which allowed no postoperative manipulation apart from massage.⁷ Subsequently, the use of nylon sutures allowed laser suturelysis^{8–10} to be performed, cutting sutures and thus manipulating flow. This was followed by the development of releasable sutures,^{11,12} which when removed at the slit lamp alter outflow facility and, most recently, the development of adjustable sutures^{13,14} where the tension can be altered by suture loosening with a specially designed pair of forceps. In addition, outflow can be modified by breaking down the scar tissue that forms around the trabeculectomy site with needling.^{15,16}

Postoperative bleb manipulation is now considered an important part of postoperative trabeculectomy bleb management. However, although the various manipulations have been acknowledged as contributing to the outcome of modern trabeculectomy surgery, the frequency with which the various

manipulations are undertaken in the normal postoperative environment has been minimally¹⁷ discussed and has never been quantified in the context of antimetabolite-augmented trabeculectomies.

The aim of this study was to identify the types and frequency of postoperative manipulations in trabeculectomy surgery, the time period over which these were undertaken, and the risk factors for intervention and relate interventions to the outcome of surgery.

METHODS

All trabeculectomies carried out by a single surgical team between October 2000 and December 2003 were included in the study. All trabeculectomies were augmented with intraoperative mitomycin C (MMC), both primary and repeat surgical procedures were considered and both limbal and fornix-based approaches were included.

Demographic and clinical information on all patients was collected retrospectively. Snellen visual acuity was converted into the logarithm of the minimum angle of resolution notation using a recognised conversion algorithm.¹⁸

An intervention was defined as any procedure or process undertaken after trabeculectomy surgery aimed at enhancing the success of the surgical outcome.

Four types of specific interventions were undertaken, all being undertaken at the slit lamp. Bleb massage was performed by applying digital pressure to the globe through the upper eyelid posterior to the posterior lip of the scleral flap, which resulted in fish mouthing of the flap and release of aqueous into the subconjunctival space. If a massage failed to produce aqueous flow or if excessive pressure was required to achieve flow, one or more of the releasable sutures was released. In cases of excessive conjunctival inflammation, a subconjunctival 5-Fluorouracil (5-FU) injection was given under aseptic conditions. The eye was prepared with topical 2.5% phenylephrine, 0.5% amethocaine and 0.5% chloramphenicol drops. A dilute solution of aqueous povidone iodine was instilled into the conjunctival fornix. The upper eyelid was retracted by an assistant, or if this was not possible or inadequate, an eyelid speculum was inserted. A 28-gauge needle attached to a 1 ml syringe was inserted into the subconjunctival space about 10 mm from the bleb and the needle was pushed through the subconjunctival space in a zigzag manner to reduce the risk of subsequent antimetabolite leakage; 5 mg in 0.2 ml of 5-FU was injected into the subconjunctival space around the bleb. If a needling was undertaken, the eye was prepared in the same way, but the bleb was entered and scar tissue was disrupted with a combination of puncturing and sweeping motions before the 5-FU injection. A needling was always accompanied by a 5-FU injection through a separate site.

The alteration in postoperative topical medication to modulate healing was excluded from the definition of intervention for this study.

Abbreviations: 5-FU, 5-fluorouracil; IOP, intraocular pressure; MMC, mitomycin C

Statistical analysis was undertaken using SPSS V.10.0. The tests for statistically significant differences between variables were performed using the χ^2 test for discrete variables, Student's *t* test for parametric data and the Mann-Whitney *U* test for non-parametric data. Two tailed *p* values <0.05 were taken to indicate significance.

The success of surgical outcome was defined as unqualified when no additional medication was required or qualified when additional medication was required to achieve the specific IOP definition. Success was also defined at two IOP cut-off points (IOP <21 mm Hg and IOP <16 mm Hg) to highlight the extent to which specific IOP end points were achieved. Two specific time points were used to define IOP outcomes. Firstly IOP at 12 months after surgery, and secondly IOP at final recorded follow-up or before starting additional medication for IOP control.

MMC concentrations varied from 0.1 to 0.4 mg/ml and the application time varied from 1 to 4 min. Three factors related to MMC application were considered for analysis, the concentration of MMC applied, the application time of the MMC and the dosage of MMC, which was defined as the product of the concentration and the application time.¹⁹ The dosage of MMC was based on the assessment of preoperative factors for increased risk of surgery failure, such as young age, Afro-Caribbean race, uveitis and repeat surgery. The number of sutures inserted into the scleral flap at the time of surgery was based on the flow from beneath the scleral flap resulting from an intraoperatively placed anterior chamber maintainer, which was adjusted in height during the procedure to estimate scleral flap flow.

RESULTS

In all, 141 consecutive trabeculectomies with intraoperative MMC and at least 12 months of follow-up were performed during the recruitment period. Second eye procedures were excluded from the analysis,^{20–21} which left 119 trabeculectomies for analysis. Table 1 shows the patients' demographics and details of glaucoma variables.

Mean (SD) preoperative best-corrected visual acuity (logarithm of the minimum angle of resolution) was stated in

114/119 patients as 0.31 (0.56; range 0–3.0; median 0.20; count fingers = 1, hand movements = 2, light perception = 3).

Bleb manipulations

In all, 93 (78.2%) patients had some form of bleb intervention (table 2).

The first intervention occurred after a mean (SD) of 15.9 (56.6) days (range 1–532 days; median 5.0 days; interquartile range (IQR) 1.0–13.5 days).

Bleb massage was performed in 58 (48.7%) patients after a mean (SD) of 17.1 (29.5) days (range 1–153 days; median 7.0 days; IQR 1.0–16.5 days). The first massage was performed after a mean (SD) of 9.9 (20.0) days (range 1–118 days; median 1.0 days; IQR 1.0–8.5 days). A mean (SD) of 1.06 (1.61, range 0–8; median 0; IQR 0.0–1.0) massages were performed for the group overall. Among those having a massage, a mean (SD) of 2.17 (1.7; range 1–8; median 1.0; IQR 1.0–3.0) episodes were recorded.

A total of 58 (48.7%) patients had at least one suture removed during their follow-up period. A mean (SD) of 0.78 (0.92) sutures were removed for the group as a whole (range 0–3; median 0; IQR 0.0–2.0). The mean (SD) time to suture removal was 41.5 (84.4) days (range 1–504 days; median 21.0 days; IQR 9.5–33.0 days). The first suture was removed after a mean (SD) of 30.5 (69.0) days (range 1.0–504 days; median 14.0 days; IQR 7.0–28.0 days).

In all, 37 (31.1%) patients were given at least one 5-FU injection after a mean (SD) of 55.2 (103) days (range 3–481 days; median 21.0 days; IQR 14.0–42.0 days). The first 5-FU was given after a mean (SD) of 40.1 (88.7) days (range 3–458 days; median 14.0 days; IQR 14.0–31.0 days). A mean (SD) of 0.57 (1.07; range 0–6; median 0) doses were given to the group overall. Among those receiving 5-FU, a mean (SD) of 1.84 (1.17; range 1–6; median 1.0; IQR 1.0–2.5) doses were given.

A total of 30 (25.2%) patients had at least one needling and 5-FU injection given after a mean (SD) of 134 (138) days (range 14–532 days; median 63.5 days; IQR 36.0–214.0 days). The first needling was performed after a mean (SD) of 97.1 (137.5) days (range 14–532 days; median 43.0 days; IQR 33.5–61.75 days). A mean (SD) of 0.39 (0.77; range 0–4; median 0; IQR 0.0–1.0) needling and 5-FU injections were

Table 1 Patients' demographics and details of glaucoma variables

	n (%)	Mean	SD	Range	Median
Men	67 (56.3)				
Age (years)		70.7	13.4	20–88	74
Presenting IOP (112/119)		29.1	8.3	14–60	28
Preoperative IOP		25.3	8.0	10–55	24
Preoperative drops*		2.8	1.1	0–5	3
Preoperative MD (91/119)		−15.3	8.1	−32 to −1	−15.3
Preoperative PSD (92/119)		8.8	3.6	2–16	9.2
Right eye	59 (40.6)				
Repeat procedures	13 (10.9)				
Follow-up (months)		19.5	9.8	12–60	12
Glaucoma types					
Inflammatory	9 (7.6)				
POAG	73 (61.3)				
NTG	15 (12.6)				
CACG	6 (5.0)				
PXF	3 (2.5)				
PDS	3 (2.5)				
Other†	10 (8.3)				

CACG, chronic angle closure glaucoma; IOP, intraocular pressure; MD, mean defect; NTG, normal tension glaucoma; PDS, pigment dispersion syndrome; POAG, primary open-angle glaucoma; PSD, pattern standard deviation; PXF, pseudoexfoliation glaucoma.

*Forty-three patients were also taking diamox.

†Other refers to ocular hypertension 1, postpenetrating keratoplasty 1, traumatic glaucoma 2, angle closure glaucoma 2, Fuchs' heterochromic cyclitis 2, plateau iris 1 and congenital glaucoma 1.

Table 2 Time to first intervention after trabeculectomy surgery (days)

Intervention	n (%)	Mean	SD	Median	Interquartile range	Range
All	93 (78.2)	15.9	56.6	5	1–13.5	1–532
Massage	58 (48.7)	9.9	20.0	1.0	1–8.5	1–118
Suture removal	58 (48.7)	30.5	69.0	14	7–28	1–504
5-FU injection	37 (31.1)	40.1	88.7	14	14–31	3–458
Needling and 5-FU injection	30 (25.2)	97.1	138	43	33.5–61.75	14–532

5-FU, 5-fluorouracil.

given to the group overall. Among those having needling, a mean of 1.57 (0.73; range 1–4; median 1.0; IQR 1.0–2.0) episodes were recorded.

In addition, five patients required intracameral Healon injection to deepen a shallow anterior chamber. One patient required three injections of autologous blood for overdrainage, and three patients required resuturing of the bleb after 12, 14 and 14 days.

Determinants of intervention

The intervention group tended towards being older (*t* test $p = 0.08$; 66.6 vs 71.8 years). There was no relationship between the MMC dose, concentration or time exposure and intervention rates (Kruskal–Wallis test). Intervention was equally likely according to sex, fornix or limbal-based flap, side of surgery and primary or repeat procedure (χ^2 test). Interventions were more likely for procedures performed by a consultant than by a fellow or a specialist registrar (χ^2 $p = 0.005$) and when >2 releasable sutures were inserted (χ^2 $p = 0.005$).

Determinants of specific interventions

Bleb massage was associated with the number of releasable sutures placed at the time of surgery. Increased numbers of sutures increased the chance of massage (χ^2 $p = 0.02$).

Suture removal was also associated with the number of releasable sutures placed at the time of surgery. Increased number of sutures increased the chance of suture removal (χ^2 $p = 0.008$).

Postoperative 5-FU use was higher in those for whom higher MMC time application (Kruskal–Wallis test $p = 0.032$) and dosage ($p = 0.05$) was used but not the concentration of MMC ($p = 0.096$).

No preoperative/surgical factors were associated with postoperative needling.

Relationship of intervention to failure

Table 3 shows the intervention rates.

The intervention group had a higher IOP at all time points and the difference was significant at days 1 ($p < 0.001$), 7 ($p < 0.001$) and 30 ($p < 0.001$), as well as at month 12 ($p = 0.008$) and at the final IOP/IOP when drops were restarted ($p = 0.009$).

Overall success rates for various IOP definitions at final follow-up were 66.4% and 73.1%, for IOPs <16 and <21 mm Hg, respectively, for unqualified success and 74.8% and 89.9%, for IOPs <16 and <21 mm Hg, respectively, for qualified success.

“Any intervention” was not associated with increased failure rates for any of the defined IOP definitions, but there was a consistent trend towards lower success in the intervention group for all definitions of success.

Bleb massage was associated with increased failure rates for both qualified and unqualified definitions of success at 16 and 21 mm Hg cut-off points. It was associated with higher IOP at all time points ($p = 0.021$ for day 1, $p < 0.001$ for day 7,

$p = 0.002$ for day 30, $p = 0.07$ for month 12 and $p = 0.06$ at the final follow-up IOP/IOP when drops were restarted).

Removal of sutures was not significantly associated with increased failure rates for any of the definitions of success used. It was, however, associated with higher IOP at all time points ($p < 0.001$ for days 1 and 7, $p = 0.029$ for day 30, $p = 0.007$ for month 12 and $p = 0.026$ at the final follow-up IOP/IOP when drops were restarted).

5-FU use was associated with increased failure rates for both qualified and unqualified definitions of success at 16 and 21 mm Hg cut-off points. This intervention was associated with higher postoperative IOP at all time points ($p = 0.001$ for day 1, $p = 0.005$ for day 7, $p = 0.07$ for day 30, $p = 0.008$ for month 12 and $p = 0.009$ at the final follow-up IOP/IOP drops were restarted).

Needling and 5-FU injection was associated with increased failure rates for all qualified and unqualified definitions of success. This intervention was associated with higher IOP at later time points ($p = 0.225$ for day 1, $p = 0.229$ for day 7, $p < 0.001$ for day 30, $p = 0.001$ at month 12 and $p = 0.001$ at the final follow-up IOP/IOP when drops were restarted).

DISCUSSION

The completion of trabeculectomy surgery is the beginning of a process that takes several months to complete. During this period, alterations in bleb morphology and aqueous outflow due to the scarring response could influence the long-term success of the surgery. There are several indicators that point to a failure of the bleb including excessive conjunctival injection and corkscrewing of vessels, flattening of the bleb, encysting of the bleb and increasing IOP. Frequent monitoring, at least weekly for the first month (and more often when required), allows changes in bleb characteristics to be identified early while a window of opportunity exists to modulate these changes. Frequent follow-up of patients in the postoperative period is therefore an essential part of the postoperative management of trabeculectomies. Many of the interventions undertaken were in conjunction with alterations in the frequency of topical steroid usage, and in some cases resulted in prolonged use of these medications.

A previous study by Marquardt *et al*¹⁷ attempted to quantify the effect of intensive postoperative management of trabeculectomy compared with a less interventional approach. They included steroid manipulation, 5-FU injections and needling in their list of interventions. They did not, however, mention the role of massage or use releasable sutures. The study was carried out in unaugmented primary trabeculectomies and was a retrospective assessment of surgery carried out by one surgeon (the intervention group) compared with those carried out by other colleagues. Success was defined as achieving a target pressure of IOP <21 mm Hg with a $>20\%$ drop compared with preoperative IOP. This study showed that similar IOPs were achieved in both groups but that the intervention group achieved the target IOP without additional medications in significantly more eyes, thus suggesting a positive result from intensive postoperative intervention.

Table 3 Number of patients (%) achieving successful outcomes for surgery at final follow-up for various definitions of intraocular pressure for the intervention and no-intervention groups

	Intervention group	No-intervention group	χ^2 p Value
Any intervention			
Unqualified			
IOP $\leq$ 16 mm Hg	59/93 (63.4)	20/26 (76.9)	0.25
IOP $\leq$ 21 mm Hg	66/93 (71.0)	21/26 (80.8)	0.46
Qualified			
IOP $\leq$ 16 mm Hg	67/93 (72.0)	22/26 (84.6)	0.31
IOP $\leq$ 21 mm Hg	82/93 (88.2)	25/26 (96.2)	0.46
Massage			
Unqualified			
IOP $\leq$ 16 mm Hg	33/58 (56.9)	46/61 (75.4)	0.035
IOP $\leq$ 21 mm Hg	36/58 (62.1)	51/61 (83.6)	0.016
Qualified			
IOP $\leq$ 16 mm Hg	38/58 (65.5)	51/61 (83.6)	0.034
IOP $\leq$ 21 mm Hg	48/58 (82.8)	59/61 (91.8)	0.014
Removal of sutures			
Unqualified			
IOP $\leq$ 16 mm Hg	34/58 (58.6)	45/61 (73.8)	0.080
IOP $\leq$ 21 mm Hg	40/58 (69.0)	47/61 (77.0)	0.32
Qualified			
IOP $\leq$ 16 mm Hg	39/58 (67.2)	50/61 (81.7)	0.064
IOP $\leq$ 21 mm Hg	51/58 (87.9)	56/61 (91.8)	0.48
5-FU injection			
Unqualified			
IOP $\leq$ 16 mm Hg	19/37 (51.4)	60/82 (73.2)	0.022
IOP $\leq$ 21 mm Hg	22/37 (59.4)	65/82 (79.3)	0.043
Qualified			
IOP $\leq$ 16 mm Hg	23/37 (62.2)	66/82 (80.5)	0.041
IOP $\leq$ 21 mm Hg	29/37 (78.4)	78/82 (95.1)	0.008
Needling and 5-FU injection			
Unqualified			
IOP $\leq$ 16 mm Hg	9/30 (30.0)	70/89 (78.7)	<0.001
IOP $\leq$ 21 mm Hg	13/30 (43.3)	74/89 (83.1)	<0.001
Qualified			
IOP $\leq$ 16 mm Hg	12/30 (40.0)	77/89 (86.5)	<0.001
IOP $\leq$ 21 mm Hg	22/30 (73.3)	85/89 (95.5)	0.002

5-FU, 5-fluorouracil; IOP, intraocular pressure.
Values are n (%).

A high proportion of our patients (72.2%) had some form of intervention. There could be two possible explanations for this: firstly, it could be argued that the concentration of MMC used in this study was generally low and this could well explain, to some extent, the frequency of interventions. In addition, in our practice, bleb manipulation is undertaken in both a reactive and a proactive way. If a bleb shows signs of failure, the intervention most appropriate to that bleb morphology and chronology will be undertaken; however, there is also a group of patients in whom it is believed that undertaking an intervention without manifest evidence of active failure could prevent this occurrence in the future or could increase the success of surgery. Marquardt only identifies interventions undertaken in the failed trabeculectomies, and therefore the total number of their patients actually receiving an intervention is unclear. In addition, the types of interventions counted in the two studies differ slightly. The IOP success for qualified IOP $\leq$ 21 mm Hg in this study (89.9%) was similar to that achieved by Marquardt (89.0%); however, the degree to which they achieved lower IOP success is not stated in their paper.

In our study, nearly 49% of patients had bleb massage performed and a similar number had suture removal; just over 31% had at least one 5-FU injection and 25.2% had at least one

needling and 5-FU procedure performed. The frequency of these interventions relates to the complexity of the intervention with the easiest, least aggressive intervention occurring most frequently and the more aggressive interventions occurring least frequently. In addition, the chronology of these interventions with median times to first intervention being 1, 14, 14 and 43 days for massage, removal of suture, 5-FU injection, and needling and 5-FU, respectively, suggests the order in which these intervention took place.

The absence of a relationship between overall intervention rates and MMC characteristics suggests that the assessment of risk used to define the MMC dosage used was generally equally accurate between both high-risk (high-dose MMC) and low-risk (low-dose MMC) procedures. This hypothesis is not entirely supported by the finding that interventions were more likely if a consultant rather than a trainee carried out the surgery, because as a general rule, the consultant would have undertaken the more complex surgery. However, the observation that 5-FU injections specifically were more common in higher-dosage MMC procedures probably reflects that these cases were in greater danger of scarring down in the post-operative period. The observation that the use of >2 releasable sutures at the time of surgery increases the subsequent intervention rate might simply reflect the need for more massage through a tighter flap before a satisfactory IOP is achieved. Indeed, further analysis demonstrates a higher massage rate in those cases in which >2 releasable sutures were used. In this group, the presence of extra sutures could necessitate more suture removal before an adequate IOP is achieved. However, although these observations are statistically significant, the heterogeneity of the group as a whole, in terms of risk factors for failure, MMC dosage and number of scleral flap sutures used, means that the results for determinants of intervention should be interpreted with some caution.

Throughout the follow-up period, the intervention group always maintained a higher IOP than the non-intervention group. This is perhaps not an unexpected finding as interventions are more likely to be undertaken in situations in which the bleb is failing or believed to be at risk of failing. However, the fact that despite these interventions, intervention is itself associated with failure highlights that although there could be intensive postoperative manipulation, many of these blebs are more likely to progress to failure. Therefore, it could be suggested, there is a group of trabeculectomies which, for whatever reason is destined to achieve low IOP even without intervention, and a group that are destined to fail even with intensive intervention. Intervention in the failing group might well prevent or delay this failure; however, the tendency is to always have a higher IOP than the group requiring no intervention.

As a general rule, the failure rate increases for intervention types with the simplest intervention, massage, associated with markedly more success than needling and 5-FU injection, again demonstrating the severity of failure at which these interventions were undertaken.

Bleb massage has existed since modern trabeculectomy was first described by Cairns.²² Traverso *et al*⁷ described the procedure in detail using a moistened cotton bud applied to the posterior edge of the trabeculectomy site and demonstrated its use in trabeculectomy. Bleb massage could be used in several situations after surgery. In patients with a flattening bleb, compression could raise a bleb and re-establish outflow. This could have the effect of reducing IOP in patients with pressure increases or might simply help to guide evolution of bleb morphology in patients with normal pressure to aid the long-term outcome of surgery and create a low, diffuse bleb of large surface area, avoiding the development of "ring-of-steel"

localised blebs. It achieves this by disrupting the fine scarring adhesion that can occur during bleb scarring.

Modulation of healing might be achieved by the use of antimetabolites, such as both 5-FU and MMC. These antimetabolites could be used in a reactive way in the context of a failing bleb where the pressure is increasing and the bleb is scarring down, and they could be used to prevent further scarring. In addition, they may be used in a predictive way where the bleb is inflamed but there is, as yet, no evidence of bleb shrinkage or pressure increase, again the objective being to prevent this from occurring. Finally, there might be situations where the risk of bleb failure is anticipated in high-risk situations, such as in previous bleb failure, Afro-Caribbean patients or ocular surface inflammation, where a prophylactic regimen of injections can be undertaken as part of the planned postoperative management.

In addition to modulation of scarring with antimetabolites in failing blebs, it is sometimes necessary to try to increase the outflow facility to lower IOP. In such cases, bleb modulation in the form of suture manipulation by suturolysis or removal or adjustment of sutures could reduce scleral flap tension and lower outflow resistance. Needling, which penetrates the scar tissue forming a capsule or cyst around the trabeculectomy site with multiple stabs or sweeping motions, re-establishes flow of aqueous from the sclerostomy into the subconjunctival space.^{15, 16} In a previous study, Gutierrez-Ortiz *et al*²³ identified 20% of their patients during the study period as requiring a needling intervention. In our study, 25.2% of patients required a needling. A mean (SD) of 0.39 (0.77) needling and 5-FU injections were given to the group as a whole. Among those having needling, a mean of just over 1.5 were undertaken, with up to four episodes in one patient. Evidence for the theoretical modulation of bleb morphology is inconsistent. Broadway *et al*,¹⁵ in their series of needlings augmented with 5-FU demonstrated a mean success of just under 60% for reduction of IOP below 22 mm Hg at the final follow-up. A significant proportion of these were carried out in the postoperative period, with the median needling time after the index surgery of 3.1 months and the earliest needling intervention at 10 days. They found no association between the timing of needling and the final follow-up outcome. However, Gutierrez-Ortiz *et al*²³ carried out needling augmented with MMC on patients who had unaugmented trabeculectomies. They defined success as an IOP <21 mm Hg with (qualified) or without (unqualified) drops. They found that the results of MMC needling were better within 4 months of trabeculectomy, suggesting that wound modulation is more successful after needling augmented with antimetabolite shortly after glaucoma surgery. One possible explanation for these different observations is the use of 5-FU in Broadway *et al*'s¹⁵ study as opposed to the use of MMC in Gutierrez-Ortiz *et al*'s²³ study.

This paper demonstrates that trabeculectomy for glaucoma is only the beginning of a process aimed at achieving satisfactory bleb morphology and adequate IOP control. Each of the various interventions undertaken has a specific role either in isolation or in combination with other interventions. It can be seen that for some trabeculectomies the postoperative period involves an evolving process of adjustments, with interventions being used in a prophylactic and reactive manner. However, despite close

monitoring and often intensive intervention, a subgroup of trabeculectomies are destined to fail.

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Competing interests: None.

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Accepted 15 January 2007

Published Online First 31 January 2007

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