Postoperative Management of Penetrating and Nonpenetrating External Filtering Procedures

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Abstract
Correct postoperative management is fundamental to prevent and treat complications and to optimize the success of filtering surgery: timely control visits and appropriate actions and prescriptions ensure the best outcomes, allow recovery from a number of untoward events, and can reestablish filtration when failure seems imminent. In contrast, a slack follow-up and wrong interventions or prescriptions can lead to failure of any surgery, no matter how accurately it had been carried out, sometimes jeopardizing vision and even the anatomy of the globe. The purpose of this review is to present a rational approach to postoperative follow-up and to synthetically describe how to prevent, recognize and address the most common complications of filtering surgery, pointing out the most common pitfalls in the management of the operated eye.

The results of filtering surgery rely crucially upon postoperative care and appropriate management of complications. In fact, no matter how perfectly a surgical filtering procedure is carried out, it can be jeopardized by inappropriate maneuvers or prescriptions during follow-up, and since more or less severe complications are common following glaucoma surgery, these must be recognized and treated adequately to ensure a favorable outcome. Moreover, a number of ‘tricks’ allow to adjust intraocular pressure (IOP) postoperatively so as to attain the desired value, raising it if it is too low, or decreasing it if it tends to lie above target.

This review summarizes the aspects that inspire a correct follow-up of filtering procedures, considering also that glaucoma surgeries are nowadays likely concentrated in few specialized centers, but most patients sooner or later return to the general ophthalmologist who referred them for surgery and who therefore is involved in maintaining a successful outcome, sharing responsibility for it. This outline does not pretend to be exhaustive in addressing the whole spectrum of complications and of their solutions systematically, but is just meant to present a practical approach to
Postoperative management, providing some hints for the treatment of the most common complications and indicating some caveats for the most frequent pitfalls affecting the general ophthalmologists’ care, in the surgeon’s experience. References are minimal for brevity, but thorough descriptions of techniques can be easily found in the huge body of literature on glaucoma surgery.

**Key Factors promoting and opposing Filtration**

The mechanisms that affect the maintenance of optimal filtration are complex, and probably individual variations in the factors determining the final aspect of a filtering bleb, along with the nature of glaucoma and the duration of disease and of exposure to topical therapies, have a great influence on the final outcome. The ideal aim of filtering procedures is obviously to achieve only a partial healing process that allows IOP to be in the desired target range, neither too high, nor too low.

Upon approaching a patient who has undergone glaucoma surgery, some fundamental dynamics must be kept in mind, being common to all situations in which external filtration is present. In addition to preoperative patient characteristics and accuracy of the surgical technique, the factors that promote filtration are:

1. **Aqueous flow**, which is the main determinant to keep any artificial exit pathway patent: although it is known that the aqueous, particularly in the early postoperative period, carries inflammatory substances that may increase bleb thickness through immediate stimulation of a vascular fibroproliferative process, it is also true that aqueous itself increases bleb permeability by promoting a slightly more delayed but long-lasting fibrodegenerative process, particularly if it is allowed to diffuse in the extracellular matrix and in the vessels of the capsule which constitutes the wall of the bleb. These opposing mechanisms have been pointed out in studying the histopathologic appearance of capsules surrounding glaucoma implant plates [1] but, specifically after filtering surgery, aqueous flow has also a merely mechanical role in keeping the bleb formed, otherwise conjunctiva and Tenon’s capsule will just stick to the flap, closing the wound and shutting down present and future filtration.

2. **Topical steroids**, which are mandatory to control the inflammatory response, which is the greater promoter of scarring at the operative site [2].

3. **Intra- and/or postoperative antimetabolites**.

   In contrast, the factors which inhibit filtration are:

1. **Any condition limiting aqueous outflow**, from reduced aqueous production to any physical obstruction.
2. **Bleeding at the surgical site**.
3. **Ocular inflammation**.
4. **Any kind of further ocular surgery**.
Many textbooks and guidelines overlook this aspect, giving it for granted, but since some unskilled surgeons happen to maintain hypotensive therapy following surgery, it is first of all necessary to emphasize that all hypotensive medications must be withdrawn after filtration surgery, in order to restore aqueous production and convey the higher possible flow through the filtration system. Medications ought even to be stopped before surgery, substituting topical drugs with systemic carbonic anhydrase inhibitors that have a more promptly reversible effect, but this may not be advisable in advanced glaucomas, in which even a short-lasting IOP spike may further damage vision. After surgery, 3 classes of drugs (common dosage and approximate duration of use are indicated in brackets) are normally prescribed:

1. A topical cycloplegic (q.i.d. for one week) to relax the ciliary muscle, thus preventing shallow anterior chamber (AC) and malignant glaucoma. Cycloplegics can be avoided after nonpenetrating surgery since the AC is less prone to become empty.

2. A topical broad-spectrum antibiotic (q.i.d. for 2–4 weeks) to prevent infection. Drops are preferred to ointments to ensure better bioavailability of other drugs, to avoid interposition of substance between the margins of the conjunctival wound and to allow better vision.

3. A topical steroid (up to 1 drop every hour in the first week, then q.i.d., and subsequently slowly tapered over 2–6 months, depending on the individual needs) to control inflammation. Especially young uveitic patients are candidates to long-lasting or even lifelong low-dose topical steroid use.

Early withdrawal of topical steroid and reintroduction of topical hypotensives in the case of IOP rise are the commonest medical errors made by unskilled general ophthalmologists and may jeopardize the outcome of surgery.

Controls are planned 1, 7, 14 and 28 days after surgery, and every 1–2 months thereafter for the first year, but the patient must be informed that complications may ensue at any time, and that extra visits are always possible. Best would be if the patient could always be visited by the surgical team who operated on the eye, but this is often impossible, and therefore correct education of patients and practitioners is crucial. Nevertheless, complications ought to be managed by the surgeon, to maximize the probabilities of success and prevent medicolegal issues, as far as possible.

**Recognizing Complications: Key Clinical Variables**

Despite uneventful surgery, optimal technique, and appropriate postoperative medication, complications are relatively common following filtration surgery, and must be promptly recognized and treated to prevent failure and visual disasters. When
examining an operated patient, there are three variables that must always be observed to correctly assess the clinical state of the filter:

1. The IOP, which must spontaneously range within target and, at least in the early and mid-term follow-up of penetrating surgery, should respond to ocular massage.
2. The AC, which must be deep.
3. The bleb, which must be present and possibly broad, diffuse, neither hyperemic nor ischemic. At least in the early follow-up, it should also expand with ocular massage.

Every time that one (or more) of these variables does not meet our expectations, adequate measures must be taken to restore an optimal postoperative outcome. In the following sections, some of the most common scenarios will be addressed in greater detail. It is of utmost importance to remember that the eye behaves like any other hydraulic system, and that IOP is the result of a balance between aqueous production and facility to outflow: if the IOP is too high, there must be a restriction to flow, somewhere along the natural or artificial outflow pathway, whereas if the IOP is too low, there must be either an insufficient aqueous production or an excess outflow. Taking one's time in observing the eye, examining the whole pathway followed by the aqueous exiting the system, and therefore detecting where the malfunction lies, is mandatory before setting forth any medical or physical countermeasure, to avoid errors in the management of complications which can be detrimental and promote a complete failure.

It is also important to be aware that although complications are more common in the early postoperative period, a patient who has undergone a filtering operation may develop untoward consequences throughout his or her whole life, and must therefore be instructed to contact an ophthalmologist every time he or she perceives unusual symptoms. It is also convenient to suggest to all patients to keep a bottle of topical antibiotic at hand and start a self-medication in case of exposure to infectious situations and especially in case of presence of eye redness and discharge, seeking advice from a specialist as soon as possible.

**Early Complications (Days to Weeks after Surgery)**

*The IOP Is Too Low!*

Hypotony is defined as the presence of an IOP stably below 6 mmHg, and is caused by a reduced aqueous production and/or an excess outflow. If the IOP is too low, observe the bleb: if it is flat, check for early bleb leaks, either from the suture or from inadvertent perforations. Even if the AC is shallow, it generally contains enough aqueous to elicit a positive Seidel test with a delicate massage.

Observe the fundus, to detect possible choroidals, but also to rule out an unlikely but possible inadvertent eye perforation occurred during local anesthesia.
If there is no aqueous leak and no globe perforation, one must assume that there is an aqueous shutdown. This is most often due to persistence of the effects of hypoten-
sive therapy and to possible mitomycin C (MMC) toxicity [3], and is generally transient and self-resolving. This may not be the case if the patient had undergone previous cyclodestructive procedures, which for this very reason constitute a relative contraindication to filtration surgery. In contrast, an elevated, large or diffuse bleb indicates the presence of early overfiltration.

Management of Early Bleb Leaks
At the end of any filtering procedure, the bleb should be tested by filling it with balanced salt solution (BSS) to rule out and seal any leak from the wound or from inadvertent buttonholes, particularly if MMC was used. Despite this care, a leak can develop during the follow-up, and may be more frequent in fornix-based flaps due to the massaging effect of blinking. Spontaneous repair is common in 2–6 weeks if no antimetabolites were used and if the scleral wound is entirely covered by conjunctiva.

Healing can be accelerated by steroid tapering and a limbal leak can benefit from application of a soft therapeutic contact lens, whereas eye patching is controversial due to the pressure that it may exert on the eye. Coverage with topical broad spectrum antibiotic is controversial but advisable in the author’s opinion. Any leak that does not resolve spontaneously in 2–3 weeks, and all leaks occurring in eyes exposed to MMC should be approached more aggressively, also because, paradoxically, the leak prevents bleb formation and favors adhesion of the conjunctiva to the sclera and eventual filter failure. Proposed nonincisional solutions include cyanoacrylate glue, fibrin glue and autologous blood injection, but a new suture is often the safer and most effective solution at this stage, and is mandatory if the leak occurs in correspondence to the scleral wound.

Management of Early Overfiltration
A too brisk aqueous flow through the system produces not only a low IOP, but often also a too large or diffuse bleb. During surgery, overfiltration should be prevented by appropriately apposing the flap to its bed, and by suturing it tightly enough to achieve a minimal aqueous oozing elicited by gentle depression of the sclera surrounding the flap with a cotton swab or a blunt tip (flow test), particularly if MMC is used. Flap sutures should be passed without transfixing the flap with bites that may create full-thickness passages for the aqueous and the AC should be stably deep before the conjunctiva is closed. Despite surgical accuracy, the restoration of aqueous production and the lysis of fibrin or blood partly sticking the flap may give rise to postoperative overfiltration, which to a certain extent tends to diminish spontaneously due to normal wound healing, but may not always do so, especially if MMC was used.

If the IOP is low but ‘non-zero’, and the AC is not flat, two medical strategies deserve consideration in this phase for their simplicity: tapering or temporary withdrawal of topical steroid, and administration of aqueous suppressants. The first is meant to allow some inflammation, promoting the scarring process, whereas the latter, which seems
paradoxical to many patients and to some inexpert colleagues, is aimed at reducing aqueous flow, which as mentioned above is a key factor in maintaining the filtering system patent. Aqueous suppression should be kept for a couple of weeks and rapidly reversible agents, like oral carbonic anhydrase inhibitors, should be preferred. If hypotony persists, further steps are mandatory to avoid choroidal and hypotony maculopathy, which is more frequent in younger subjects and myopic eyes [4], as well as to improve visual acuity by restoring a physiological shape of the eye.

A procedure that can be performed to reduce aqueous outflow, either at the slit lamp or under the operating microscope, is autologous blood injection: 0.5 ml of blood is drawn with an insulin syringe with a 23-gauge needle from the patient’s antecubital vein; the needle is changed with a 27- or 30-gauge one, which is introduced under the conjunctiva starting 3–5 mm away from the bleb, and part or all the blood is injected inside and around the bleb. Blood reflux in the AC is common and to some extent advisable, since it prompts a more effective cut in aqueous flow thanks to the clot plugging the internal sclerostomy and gluing the flap to its bed. The patient should be warned about possible transient visual reduction. The maneuver is simple but not easily titratable, and therefore strict follow-up is necessary to readily detect possible IOP spikes, and in case of failure it can be repeated. The blood injection can also be integrated by the passage of compression sutures.

If the cause of overfiltration is a too loose closure of the flap, either primitive or following an untimely and too generous suture lysis, as well as if hypotony is very deep or accompanied by a flat AC lasting for over one week, one must consider surgical revision of the flap sutures or patching with a scleral graft if the tissues are too thin and spoilt, specially following the use of MMC. This choice is hastened by impending hypotony maculopathy.

Management of Hypotonic Flat Anterior Chamber

If the AC of a hypotonic eye is not deep, we must assess and note how ‘flat’ it is: it can be just shallow without endothelial touch, or shallow enough to display an iridocorneal contact, peripheral or mid-central, or finally in can be so empty as to cause a lenticulocorneal touch. Obviously, hypotony must be concomitantly and separately addressed as mentioned in the previous section, and less severe cases of shallow AC may simply resolve just by restoring a normal IOP. In contrast, a central corneal touch must be treated within 7–10 days, considering the corneal damage [5], the quick cataract formation in phakic eyes, and the risk of peripheral synechiae formation with failure of the filter. A peripheral touch may be just observed but should be treated surgically if it does not resolve spontaneously.

The AC can be reformed with air, gas, BSS, or viscoelastics injected through the service paracentesis that ought to be made during filtering surgery. The author favors viscoelastics, which seem overall safer, since they last longer than air and BSS, they are noncataractogenous and are isovolumetric independent of IOP (unlike gases). Viscoelastics offer a broad range of cohesiveness, and perhaps the best compromise
is offered by thixotropic substances like Healon 5 [6]. Upon viscoelastic injection, the AC should be filled as much as possible, but care should be taken not to raise the IOP too much, to avoid the deleterious effects of a possible acute IOP spike, but also to avoid breaking the outflow system which was already not tight enough, causing an untoward expulsion of the bulk of viscoelastic into the bleb, with even deeper hypotony. Finally, we must remember that a shallow AC in the presence of a nonhypotonic eye may in fact represent the onset of a malignant glaucoma.

Management of Hypotonic Choroidal Effusion

If a hypotonic eye, particularly a pseudophakic one, displays a shallow AC, we can assume that something is occupying some space in the vitreous cavity. With an IOP in the 0–5 mmHg range, it is likely, although not always true, that fluids leak from the choroidal vessels in the suprachoroidal space, generating a choroidal detachment. The condition is favored by high preoperative IOPs, ocular inflammation, which tends to reduce aqueous production and increase the permeability of choroidal vessels, raised episcleral venous pressure (as in Sturge-Weber syndrome), and thick sclera compressing vortex veins (as in nanophthalmos, in which prophylactic sclerotomies should be considered before filtering surgery). Hypotony causes choroidal effusion, which in turn increases uveoscleral outflow and reduces aqueous production due to ciliochoroidal detachment, in a vicious cycle that often requires some external action to be broken, although observation alone can be an option in peripheral effusions which reabsorb spontaneously as the IOP usually rises a little over the first postoperative weeks.

Choroidals must be mapped on every visit, by ophthalmoscopy and by echography, which reassures about the serous nature of the effusion, or detects the presence of blood in the suprachoroidal space, indicating a different pathogenic mechanism such as a subtle suprachoroidal hemorrhage. Care must be taken to rule out the coexistence of a serous or rhegmatogenous partial retinal detachment. Treatment of hypotony is surely a good option to revert choroidals, but it may not be sufficient, and later it may even be untoward, leading to high IOP as soon as the effusions disappear. Aggressive treatment of inflammation with topical and especially systemic dexamethasone (1 mg/kg a day for one week, then tapered, associated with a gastroprotective agent) may be greatly beneficial. Surgical drainage must be considered in the case of long-lasting effusions impairing the visual field, particularly in ‘kissing’ choroidals lasting over one week, due to the risk of permanent retinal folds and retinal adhesions that may precipitate a retinal detachment upon reabsorption of the suprachoroidal fluid.

The IOP Is Too High!

A high IOP indicates an increased resistance to aqueous outflow. Before acting in any way, we must analyze where the excess resistance is generated, ideally following and examining the whole outflow pathway.
The first aspect that must be evaluated is the depth of the AC, which must be normal. A shallow or flat central AC with high IOP indicates the occurrence of a malignant glaucoma, due to a cilio-lenticular block, until proved otherwise, and even a normal or nonhypotonic IOP with a shallow AC must be regarded as suspicious. A shallow peripheral AC with iris bombé and deeper central chamber indicates a pupillary block, which can occur, particularly in phakic eyes, if iridectomy was inadequate or was not performed, as in nonpenetrating procedures or Ex-PRESS implantations.

We should then observe the internal sclerostomy to verify that it is patent and that nothing (vitreous, corneal tissue in case of incomplete sclerostomy, iris strands or blood) causes an ostium obstruction. In the case of nonpenetrating surgery, the descemetic window should be observed to rule out iris apposition and possible filling of the intrascleral lake with blood coming from Schlemm’s canal.

If the internal ostium of trabeculectomy is free, the appearance of the bleb is crucial: if the AC is deep and the bleb is flat, the block lies in between, at the level of the flap, which may be sealed owing to too tight sutures, or to adhesion to its bed due to blood or fibrin.

At this point, ocular massage is a very useful tool to verify the patency of the filter, and to restore and promote filtration. If massage is ineffective in restoring a full bleb and lowering IOP, release of flap stitches, either by laser suture lysis, or by manipulation of releasable sutures, must be considered.

If, despite suture lysis and ocular massage, the IOP is high and the bleb flat, we must assume that the flow is blocked by bleb fibrosis. Finally, if both IOP and bleb are high, the resistance to outflow lies in the bleb wall which is too thick and impermeable due to bleb encapsulation.

In examining the operated patient with a flattening bleb and raising IOP, we must be aware that no matter where the obstruction to flow lies, if this is not promptly treated, surgery is soon going to fail due to bleb scarring, since aqueous flow is a key factor in keeping the bleb formed and maintaining filtration. For the same reason, at this stage, two common and detrimental errors made by inexpert ophthalmologists must be avoided: reintroduction of hypotensive agents, which further cut aqueous flow through the filter and hasten its failure (we already discussed the use of aqueous suppression to treat hypotony), and the withdrawal of topical steroids for fear of a steroid-related IOP rise (steroids may cause an increased physiologic trabecular resistance, but in the operated patient the outflow pathway is artificial: a reduction in the minimal physiologic outflow may even be beneficial since more aqueous is conveyed through the surgical site), which leaves free field to inflammation, fibrosis and filter failure.

Management of Malignant Glaucoma
In case of high (or even normal) IOP with shallow or flat central AC, it is mandatory to carefully observe the fundus, and perform a B-scan echography to rule out the presence of a suprachoroidal hemorrhage. If no space-occupying condition is detected
in the vitreous cavity, the presence of aqueous misdirection due to a ciliolenticular block must be postulated. Malignant glaucoma is uncommon but not so rare, since it complicates 2–4% of trabeculectomies in phakic eyes with angle closure glaucoma [7], and its occurrence has been reported occasionally practically after any surgical or parasurgical ocular procedure, including nonpenetrating surgery [8], glaucoma drainage device surgery [9], and even bleb needling [10]. As soon as the diagnosis is confirmed, attempts must be made to break the ciliolenticular block and revert the aqueous misdirection, first of all by strongly intensifying the topical cycloplegic therapy. Increasing topical steroid therapy is also beneficial to minimize inflammation, corneal damage, PAS formation and bleb scarring, since external filtration is greatly reduced or absent. Aqueous suppressants are necessary if IOP reaches painful levels and puts intraocular perfusion in hazard, but they can also help to restore an anteriorly directed aqueous flow by reducing the aqueous flow and the amount of it that pools in the vitreous cavity. Hyperosmotics can be useful to reduce IOP, but specifically to shrink the vitreous body, thus favoring a release of the ciliolenticular block.

In pseudophakic eyes, Nd:YAG laser capsulotomy, associated possibly with disruption of the anterior hyaloid, as first proposed in 1984 by Epstein et al. [11], can resolve the vicious cycle of aqueous misdirection and ought to be tried as soon as the complication is detected. In case of failure of the previously described medical and laser procedures, a further tip is to try to break the block at the level of the ciliary body and zonules, by shrinking some ciliary processes and the adjacent zonules and vitreous, either by direct argon laser photocoagulation through the peripheral iridectomy [12], or by contact transscleral cyclophotocoagulation [13].

Medical therapy is successful in approximately 50% of the cases [14], and further cases may be resolved by laser maneuvers, but if the conservative approach is ineffective, the severity of the condition makes pars plana vitrectomy with accurate cleaning of the vitreous base and disruption of the anterior hyaloid necessary, possibly in association with lensectomy in phakic eyes, with success rates approaching 100% [15], although the filtering procedure may fail due to secondary surgery.

Experience on the field tells that, as far as malignant glaucoma is concerned, there are two pitfalls that may induce inexpert ophthalmologists in conceptual errors that must absolutely be avoided for their disastrous consequences: the first is to label the condition as a primary acute angle closure glaucoma and to treat it with miotics (which further squeeze the lens-iris diaphragm against the cornea and increase the aqueous misdirection), and the second is to disregard the flat chamber and try to lower IOP by facilitating aqueous outflow, cutting the flap stitches and needling the bleb, therefore eliminating the only counterpressure that may oppose a complete emptying of the AC.

Management of Obstruction of the Internal Ostium of Trabeculectomy
The internal sclerostomy may be plugged in the first postoperative days by a clot of blood coming from the iridectomy, by iris strands in case of inadequate iridectomy, or by a
Postoperative Management of External Filtering Procedures

Ocular Massage
Ocular massage allows to assess the function of a filtering system and to promote filtration by forcing aqueous through it, and therefore elevating and expanding the filtering bleb. An IOP reduction following massage lasts shortly since aqueous production restores the previous IOP values in few minutes, but demonstrates the patency of the filter. Moreover, the maneuver, performed by the physician and reiterated by the patient, helps to attain lower IOPs permanently.

During a visit, the author's choice is to perform massage in the superior sector (at the slit lamp so that the effects on the bleb can be directly observed) by pressing the open superior eyelid with a finger, or depressing the conjunctiva at the edge of the flap with a cotton swab or a Hoskins lens, to misalign the flap edges, disrupt possible adhesions in formation and flush debris through the filter. The force applied and the site of depression can be varied and increased until the desired effect is obtained. This maneuver is particularly important on the first postoperative day, when it frequently ‘initiates’ bleb formation when the flap tends to stick to its bed due to the presence of fibrin or blood under it.

As for self-massage, the patient must be carefully instructed since complications (bleb rupture, subretinal hemorrhage, iris incarceration, dehiscence of penetrating keratoplasty, etc.), although rare, are anecdotally reported: we advise to perform it alternatively with two digits in the superior sector for 10–20 s while looking down with the eye shut. The frequency and the strength of the procedure must be tailored to the specific need, and it is advisable to have the patient perform it in front of the physician for the first time for best education, checking also the effects on IOP so that a direct feedback is provided.

The acute IOP drop, and the delayed beneficial effects of ocular massage are maximum in the first postoperative days, and tend to become less evident over time, becoming virtually null at 6 months [16].

Laser Suture Lysis and Releasable Sutures
If the IOP is above target, the internal ostium of trabeculectomy is patent, and massage does not elicit bleb filling and IOP drop, the flap sutures can be cut by delivering 50-μm
spots with a thermal laser (a red beam may be more effective if blood is present) using a Hoskins lens (or the edge of a 4-mirror goniolens or any other transparent device) to flatten the bleb against the suture and achieve blanching of conjunctival vessels for optimal visualization and firing. If possible, lysis should be delayed for some days after surgery, particularly if MMC was used. The procedure is generally ineffective if more than one month has elapsed after surgery, but late lysis may still be effective. If the suture is not tight, the laser spots just heat and loosen the nylon thread, whereas a successful lysis should also cause a separation of the cut edges [17]. Complications include wound dehiscence if the lens damages the conjunctiva and conjunctival perforation in the case of laser overexposure or presence of blood under the conjunctiva, but the most common and troubling one is hypotony, occurring in up to 21% of the eyes, and its possible spectrum of consequences including malignant glaucoma in 2% of the cases [18]. For this reason, lysis should involve one stitch at a time, followed by IOP check and new massage, and the Hoskins lens itself can be very useful in selectively depressing the sclera around the flap, to misalign it and favor aqueous flow.

Releasable sutures are specifically recommended in the case of thick Tenon’s capsule or in any other condition at risk for a difficult visualization for laser lysis. Partial release is also possible. Effects and complications are similar to those of laser lysis, although sutures with unburied ends may be irritating. Releasable and nonreleasable sutures can coexist, at the surgeon’s convenience.

Management of Bleb Encapsulation and Fibrosis: Needling Procedures
In 9–15% of the cases, mostly between 2 and 4 weeks from surgery, the bleb becomes high and circumscribed due to encapsulation and the IOP tends to rise. In these cases, some authors propose a medical management based on the reintroduction of hypotensive drugs [19, 20], and the only small-size randomized study supports this approach [21], postulating that a high IOP may further stimulate bleb fibrosis, whereas simple reduction of the tension in the bleb wall may be of help, but since this strategy contradicts the key assumption of filtering surgery that the aqueous flow be the major factor favoring filtration, the author advises a more aggressive treatment to restore a broader aqueous diffusion. Such approach is even more reasonable in the case of increased bleb vascularity with corkscrew vessels indicating a reactive state that is likely to lead to bleb fibrosis and thickening, with possible reduction of bleb area and height and is therefore a sign of impending failure. All these conditions, especially if associated with an IOP rise and with a decreasing response to digital massage, represent an indication for needling, which should be considered before restarting hypotensive therapy or reoperating the patient.

The author usually performs bleb needling at the slit lamp, with a 27- or 30-gauge needle mounted on an insulin syringe, in association with 5-FU injection (highly diluted MMC can be an alternative), which is delivered subconjunctivally at the same site, before or after the procedure (avoiding intracameral penetration of the antimetabolite in this latter case), and/or in an adjacent or opposite quadrant. If 5-FU cannot
be used due to established or expected punctate keratopathy, concomitant injection of a steroid is recommended to counterbalance the promotion of wound healing caused by the needling procedure itself and by possible minor bleeding.

After topical anesthesia, antibiotic instillation and disinfection of the conjunctiva with iodopovidone, an assistant holds the patient’s head against the front rest of the slit lamp and delicately but firmly rolls the upper lid skin with a cotton swab. The patient is asked to look down, and the needle is inserted temporally (and/or bent and inserted nasally) 5–10 mm away from the bleb area, so as to prevent aqueous leaks, and advanced towards the bleb while gently ballooning the conjunctiva with lidocaine. If the bleb is flat, the procedure should be aimed at trying to raise it and disrupt the fibrous adhesions sealing the flap, possibly inserting the needle under the edge of the flap which can be elevated with a sweeping motion. If the bleb is encysted and high, there is no reason to attain the flap, but multiple punctures are made in the Tenon cyst.

An immediate IOP drop (at values of 10 or below) indicates that aqueous flow has been restored, and is strongly associated with a longer survival of the filter [22]. Topical antibiotics are prescribed for one week after the procedure, and a topical steroid is (re) prescribed q.i.d., as after surgery. If there is at least a temporary effect, the procedure can be repeated. Reported success rates of one or more needling procedures vary in restoring adequate aqueous outflow range from 45% (at one year) [23] to 96% at 6 months [24] depending also on the heterogeneous inclusion and success criteria.

**Mid-Term Complications (Weeks to Months after Surgery)**

The mid-term follow-up of the operated patient can reveal many of the complications already described for the early follow-up, with a prevalence of those associated with an IOP above target due to progressive bleb fibrosis and failure. Even when the target IOP is attained, the patient may yet complain about a dysesthetic bleb, characterized by ocular discomfort, with symptoms such as foreign body sensation and visual disturbances, and signs such as tear film abnormalities and dellen formation. This condition is more common if the bleb is too large, or too nasal, or if it tends to invade the cornea, and may require bleb remodeling. Another complication is peculiar to non-penetrating glaucoma surgery, and consists in the progressive reduction in permeability of the intact descemetic ‘window’, which appears inflected towards the intrascleral ‘lake’ on gonioscopy: the IOP rises, sometimes rather abruptly, but the bleb remains diffuse and nonhyperemic. This event is an indication for goniopuncture.

**Bleb Remodeling**

If the bleb is too large and extends nasally and temporally, or even over 360°, it can be demarcated and/or flattened by passing one or more X-shaped compression sutures
under topical anesthesia [25], with 9-0 nylon. The sutures ought to be securely anchored at the limbus and distally at Tenon's capsule, or better at the sclera, to allow effective tension. The functionally-excluded portions of the bleb can be filled one or more times with injected autologous blood to promote their obliteration [26]. Sutures are removed after some weeks. A bleb growing over the cornea can be shrunk with gentle cautery applications, possibly some weeks after functionally sealing the preincident portion with a compression suture, to avoid creating a limbal leak.

Management of IOP Rise following Nonpenetrating Surgery: Goniopuncture

Goniopuncture is common after deep sclerectomy: its reported frequency ranges from 41 to 71% of the cases depending on eyes included, presence and type of implant, and duration of follow-up [27]. The probability of goniopuncture being performed at 3 years from surgery is 63% with a mean interval between surgery and laser treatment of 10 months [28].

Patients and general ophthalmologists should be informed that in case of progressive (sometimes rather abrupt) IOP rise accompanied by a reduction of the bleb size and height, goniopuncture is mandatory before restarting topical therapy or performing a surgical revision in all patients with a visible and nonruptured descemetic ‘window’, because the permeability of an intact Descemet’s membrane may decrease over time. In most cases, accurate gonioscopy reveals an inflexion of the membrane towards the intrascleral lake, but this aspect may be not clearly evident. The success rates of the procedure are high, with an 83% probability of achieving immediately an IOP below 15 mmHg, and a 2-year success rate of 68% [29].

After goniopuncture, hypotony can ensue, with all its possible consequences, but this is unlikely if the treatment is not done too early, whereas the most fearful complication of abruptly establishing a brisk aqueous outflow is suction and apposition of the iris to the descemetic ‘window’, sometimes with iris incarceration in the puncture site, since nonpenetrating surgery is characterized by the absence of surgical iridectomy. This complication was observed in 25% of the cases of a recent study on 173 consecutive goniopunctures [28] and generally causes an IOP spike, with ocular pain and visual reduction.

A tip to try to resolve an iris plugging of the goniopuncture (or of the internal ostium of a trabeculectomy) is to pharmacologically induce a very deep IOP drop (to relieve the pressure that pushes the iris against and inside the puncture), to perform a peripheral Nd:YAG iridotomy (to neutralize the pressure difference between posterior and anterior chamber), and to instill pilocarpine and carry out a peripheral iridoplasty right anterior to the iris plug, to try to pull the iris out of the ‘trap’. Unfortunately, some eyes are refractory to these attempts and require iris repositioning with a spatula, and in some rare cases the plug tends to relapse, requiring a basal surgical iridectomy.
As for the treatment technique, the author had a substantial reduction in the risk of iris plugs by avoiding goniopuncture in the first postoperative month and by carrying out a preliminary peripheral iridotomy one clock hour away from the ‘window’ and a localized iridoplasty in the area facing the window. To puncture Descemet’s membrane, laser is set just above the energy used for capsulotomy, and the beam is aimed through a goniomirror at the anterior and lateral corner(s) of the descemetic window [28]. I advise to stop shooting and check IOP as soon as a microhole is made in the membrane (microbubbles drained through the perforation often allow to witness it). At all subsequent controls, gonioscopy is performed to check the patency of the system.

Practically, and in terms of success, goniopuncture converts a deep sclerectomy into a trabeculectomy [30]. If following goniopuncture the IOP is still above target, deep sclerectomy can be further managed as a trabeculectomy, with laser suture lysis, needlings and 5-fluorouracil injections. In some cases, if IOP rises again over time, repeat goniopuncture can prove successful, probably because the initial one was very little or was blocked by tissue debris. The only maneuver that must be avoided or performed with great care is ocular massage, for the risk of iris incarceration that it brings about.

Goniopuncture can be carried out also after viscocanalostomy with significant hypotensive effect (37% of the eyes, 9 months after surgery on average, in a study of 57 eyes, with a mean immediate IOP drop of 39%) [31], although the aqueous dynamics may be different if no external filtration is present.

**Late Complications (Months to Years after Surgery)**

The most common untoward event that may occur months to years after filtering surgery is progressive filter failure: the patient comes back to the office several months after a last visit, with a high IOP unresponsive to ocular massage and with a flat and adherent bleb, either surrounded or completely invaded by tenacious fibrosis. Needling can be tried but is generally useless: the patient must be prescribed topical hypotensives, and is a potential candidate to new surgery. In contrast, particularly after MMC trabeculectomy, sometimes the bleb tends to become thinner and thinner due to the slow fibrodegenerative and erosive action of the aqueous, and finally the patient comes back to the office for an unscheduled visit, complaining about visual reduction and tearing, and biomicroscopy reveals a late bleb leak, with either a diffuse or a localized Seidel phenomenon, or even with bleb rupture due to inadvertent rubbing or trauma.

One final dreadful complication, always possible even many years after successful surgery, is bleb infection and endophthalmitis. All patients undergoing filtering surgery must be warned to limit exposure to potential sources of infection such as dirty water or dust and to keep a bottle of broad-spectrum antibiotic drops at hand starting hourly instillations and seeking specialist advice in case of ocular discharge, conjunctival hyperemia, ocular pain and blurred vision.
Management of Late Bleb Leaks

Late leaks can be managed like early ones, but small thin blebs do not allow autologous blood injection, and most frequently the conjunctiva is too avascular and friable to allow suturing. In these cases, particularly those with minimal localized or diffuse Seidel phenomenon, a conservative approach consists in covering the bleb with a double layer of amniotic membrane, anchored with several 10-0 nylon mattress sutures. In addition to topical antibiotics, hypotensives are administered to reduce aqueous flow that would form a secondary pseudobleb between the conjunctiva and the amniotic membrane, thus limiting its repairing action. The discomfort created by the sutures can be partly reduced by applying a soft contact lens. When the conjunctiva is too compromised or torn, the only solution is to excise or de-epithelialize the compromised bleb area and cover it by mobilizing the fresh adjacent conjunctiva (separate dissection of conjunctiva and Tenon's capsule makes stretching easier), or by realizing a rotational or free tissue graft. Little or no tension should be applied to the sutures closing the cleft to avoid likely subsequent retraction of the graft with a relapse of the leak. Sometimes, the whole surgical site is severely compromised with full thickness leaks due to erosion of both conjunctiva and sclera (particularly in patients operated on during the early 1990s, with prolonged exposure to high MMC concentrations). These cases require a more thorough reconstruction, with patching of the sclera with pericardium or donor sclera in addition to conjunctival recovering.

References

Postoperative Management of External Filtering Procedures


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