Postoperative Hypotony

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ABSTRACT

Ocular hypotony is a complication that is potentially vision-threatening and seen following different types of glaucoma surgeries compromising either the globe integrity or aqueous humor dynamics. The treatment almost always aims to correct pathology underlying ocular hypotony. Visual function can usually be restored after restoration of anatomic integrity. Here, we review the pathophysiology and treatment options in ocular hypotony caused by different types of glaucoma surgeries and procedures.

Key Words: Ocular hypotony, Glaucoma surgery, Trabeculectomy, Seton surgery, Hypotonous maculopathy.

INTRODUCTION

Hypotony is an important problem that develops due to disruptive effects on humor aqueous dynamics such as production and efflux and threatens visual function.

Currently, several definitions are present for hypotony.[1] First definition is termed as statistical or numeric hypotony and is defined as intraocular pressure (IOP) less than 6.5 mmHg, which is more than 3 standard deviations below the mean IOP.[2,3] However, this definition includes no clinical data regarding presence or development of complications that threaten vision.

Thus, World Glaucoma Association considers hypotonic IOP value that may accompany to clinical complications with potential to threat visual functions as ≤5 mmHg in guidelines on "Design and Reporting of Glaucoma Surgical Trials".[4] In recent years, there are ongoing efforts to seek more controlled micro-invasive surgical techniques using several micro-implants to avoid vision-threatening complications such as hypotony in glaucoma surgery. However, filtering surgeries, particularly seton surgery and trabeculectomy, are only options in all patients requiring rapid and effective IOP reduction. Hypotony is most concerning complication that may be encountered at any time in filtering surgeries.[5-11] Postoperative hypotony may develop following retina, cataract, cornea and strabismus surgeries in addition to filtering glaucoma surgery. In this review, we discuss physiopathological mechanisms of ocular hypotony caused by filtering glaucoma surgeries and perioperative measures that should be taken to prevent hypotony and current hypotony treatments.

Ocular Hypotony Following Trabeculectomy

Three critical areas ensuring humor aqueous efflux are created during trabeculectomy surgery: 1) sclerostomy; 2) scleral flap; and 3) subepiscleral/subconjunctival areas (Figure 1). The humor aqueous passing to subepiscleral

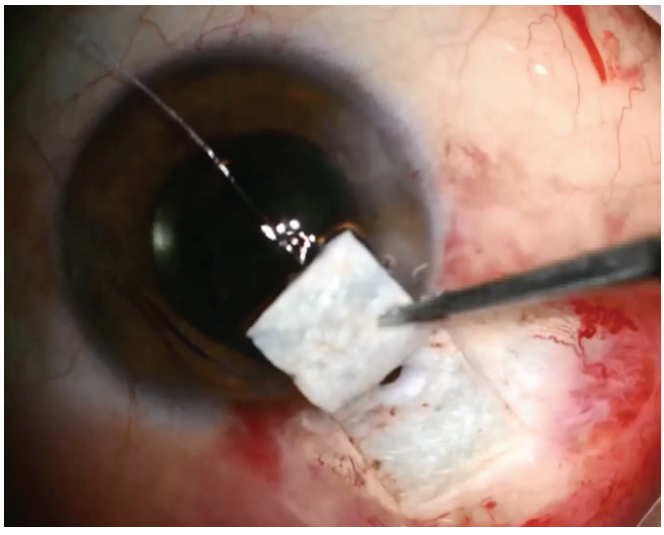

Figure 1. *In trabeculectomy surgery, sclerostomy, scleral flap and subconjunctival/subepiscleral area play an important role for dynamics of humor aqueous efflux.*

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or subconjunctival space accumulates in these spaces and reaches to systemic circulation via several pathways. Since a challenging process begins and risk for loss of vision is substantially increased when hypotony is developed, the above-mentioned intraoperative areas should have to be controlled meticulously to prevent hypotony development.

Trabeculectomy has been most commonly used surgical technique to prevent IOP in cases with glaucoma. Trabeculectomy was first defined by Cairns and Watson.[12,13] In fact, the surgical procedure termed as trabeculectomy is sclerostomy or keratectomy if performed more posteriorly. Studies on effectiveness of sclerostomy showed that small-sized sclerostomy leads higher increase in humor aqueous efflux in a scleral flap at any shape or size on contrary to expected, proposing an optimal sclerostomy size of 0.5 mm.[14-16] Again, it was shown that, compared to round sclerostomy, semi-circular sclerostomy provides 6.6% higher humor aqueous reflux.[16] In addition, it has been demonstrated that sclerostomy alone is not the only factor important for effectiveness of filtration, rather, flap size: sclerostomy size is more predominant factor for filtration effectiveness. Humor aqueous efflux is increased by increasing flap area: sclerostomy area ratio.[16] These findings make micro-trabeculectomy procedures more important for effectiveness.[17]

Primary function of scleral flap, another intraoperative factor, is to prevent hypotony by resisting humor aqueous reflux. For this purpose, scleral flap should be large enough to cover sclerostomy.[18] There is no optimal or standard scale for flap shape and size. However, there are studies suggesting better drainage with square- (4x4 mm) or trapezoid-shaped when compared to triangular flaps.[16,19,20] Scleral flap should not be extremely thin. Half thickness of sclera is optimal size.[15] Extremely thin flaps increase risk for hypotony since they do not have sufficient tension to control efflux. Increased flap thickness implies higher tissue rigidity. Drainage of humor aqueous beneath flaps become more challenging as tissue rigidity is increased. Scleral flap positioning can differ by shape of scleral flap. Regardless of flap tension provided by sutures, thinner flaps facilitate humor aqueous efflux and result in lower pressure.[19,21]

Hypotony in Uveitic Glaucoma

Both ocular hypertension and hypotony are frequently seen in patients with uveitis. In a retrospective study on non-infectious uveitis, hypotony incidence was found to be rather low (0.61%% eye-year).[22] It is known that hypotony may also develop in infectious uveitis.[23] Risk for hypotony is higher in anterior uveitis and panuveitis when compared to intermediate or posterior uveitis. This is explained proximity of focus of inflammation to ciliary body.[22] In eyes with IOP elevation secondary to uveitis, response to anti-glaucomatous treatments is highly variable and even one drop of eye drop that decreases humor aqueous production can lead hypotony in some cases.[24] Again, risk for hypotony is rather high following cataract, vitrectomy or glaucoma surgery in uveitic eyes (Figure 2).[22,25-29] Thus, one should consider risk for progression of glaucoma and extremely low IOP development during decision-making process for surgical intervention in a patient with uveitis. Although all glaucoma interventions cause hypotony in inflammatory or uveitic glaucoma, deep sclerectomy, seton surgeries such as Ahmed glaucoma valve (AGV) or Schlemm canal-based surgeries are preferred rather than trabeculectomy in order to minimize risk.[25-27]

Anti-metabolites and Hypotony

Lower IOP values can be achieved at postoperative period as a result of anti-fibrotic agents such as mitomycin C (MMC) or 5-Fluorouracil (5-FU) during trabeculectomy (Figure 3).[30,31] However, there is an increase in complications such as bleb leakage and hypotony by use of anti-fibrotic agents. In particular, avascular cystic bleb formation develops due to anti-metabolite use such as MMC or 5-FU.[32] In such cases, delayed hypotony rate is 2.8-12.9%.[33,34] In cases with bleb leakage and hypotony, optimal treatment should be eliminating bleb and hypotony at target IOP levels with preservation of filtration. Many non-surgical methods are recommended for this purpose including bandage contact lens use, agents suppressing humor aqueous production, topical lubricant agents and cycloplegia as first-line modalities.[35] If conservative approach fails, minor interventions needling, intra-bleb autologous blood injection, symblepharon ring, laser treatment, bleb cross-linking or fibrin or cyanoacrylate adhesives can be attempted.[36-43] If these minor interventions also fail, surgical revision may be required for more effective outcome, including trans-conjunctival compression suturing, cryopexy over bleb, closure of trabeculectomy area with patchy graft, amnion membrane transplantation, bled area reduction and conjunctival advancement.[44-51]

Seton Surgery and Hypotony

Currently, in addition to Seton surgery, valve (AGV- New World Medical, Inc.,Rancho Cucamonda, CA) or non-valve implants (Baerveldt- Abbott Medical Optics, Inc., Santa Ana, CA ve Molteno- Molteno Ophthalmic Limited, Dunedin, New Zealand) are used in the Seton surgery that is another common glaucoma surgery. Based on data from Ahmed Baerveldt comparative study and 5-years data from Ahmed vs. Baerveldt study, it was shown that non-valve Baerweldt implants can provide higher reduction in IOP

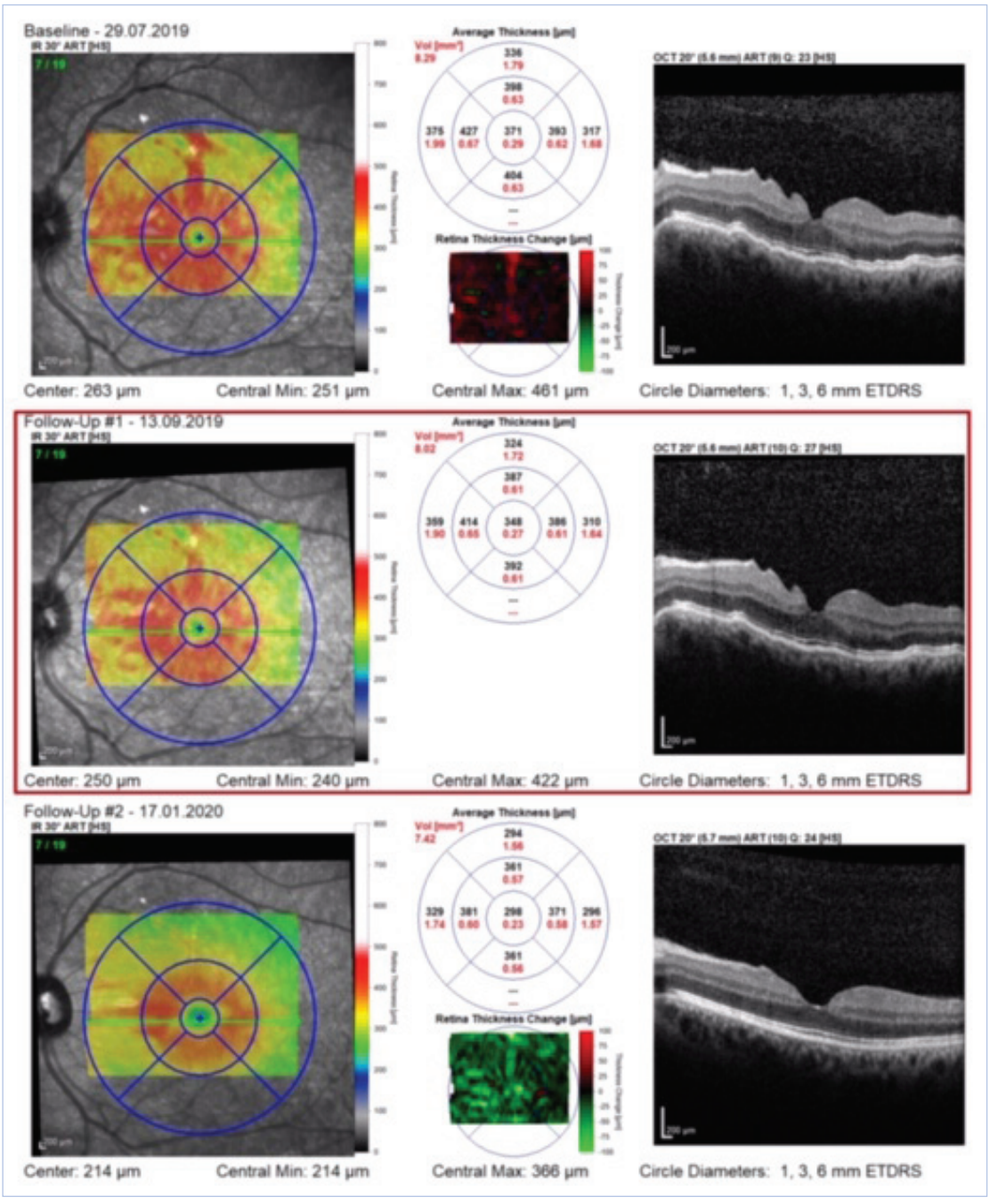

Figure 2. *Follow-up of hypotony maculopathy following uveitic glaucoma surgery by macular OCT evaluation.*

and less need for anti-glaucomatous agents. However, risk for hypotony was found to be higher in when compared to valve implants.[7,8] Theoretically, although it has been reported that valve implants do not decrease IOP below single digit level, it is known that hypotony may develop in patients underwent valve implant surgery in practice.[52,53] In AGV implants, hypotony-related persistent failure rate was reported as 0.4% while it was reported as 4.5% in non-valve Baerveldt implant.[8] In non-valve implant surgery, complete tube ligation by either absorbable or non-absorbable suture is recommended as an important measure to prevent hypotony (Fig ure 4).[53,56] When tube ligation is performed using absorbable suture, ligation is opened on postoperative weeks 5-7.[57] It is less likely to open early when absorbable sutures are used; however, premature opening was reported in rare instances.[53] Thus, although absorbable suture reduces risk for early opening, it does not completely eliminate recurrence of hypotony. Anti-glaucomatous agents are generally needed until tube re-opening. However, close clinical follow-up and optimal timing for withdrawal of hypotensive agents are highly important to prevent hypotony.

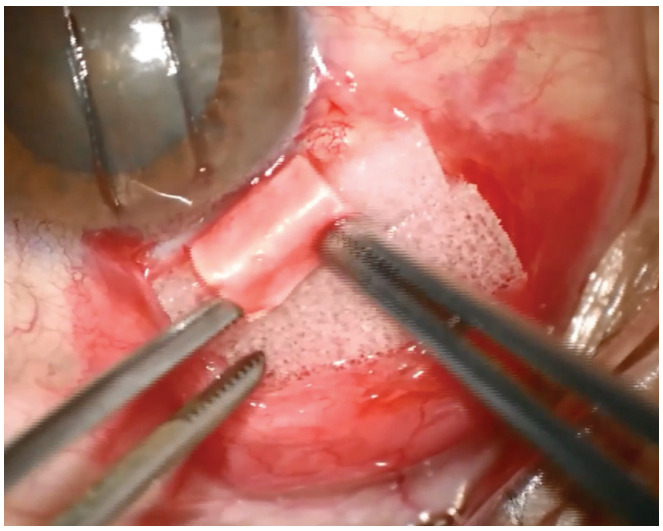

Figure 3. *Mitomycin C is commonly used to achieve lower intraocular pressure during postoperative period in trabeculectomy.*

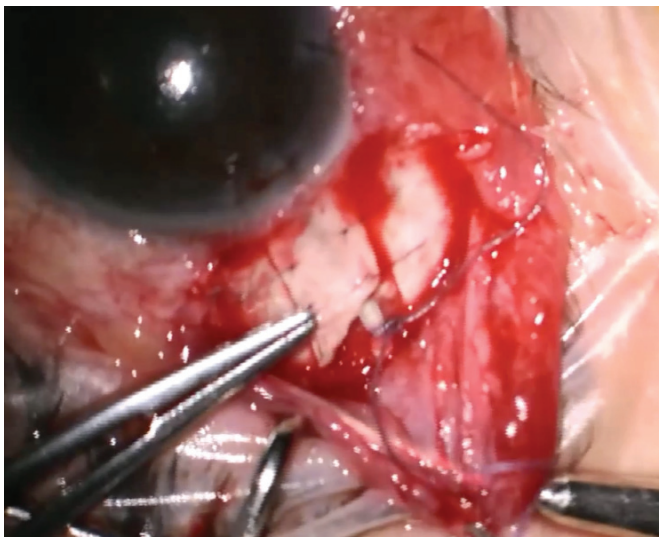

Figure 4. *Treatment of hypotony following Seton surgery: Tube ligation.*

Some authors recommend viscoelastic substance of perfluoropropane gas injection to anterior chamber in conjunction with tube ligation.[52,58] In case of failure, ab interno stent, tube shunt plate truncation and implant explantation are other surgical methods that should be considered.[59-61]

Laser Suturolysis and Hypotony

In laser suturolysis (LSL), it is aimed to improve insufficient aqueous bleb formation and filtration function following trabeculectomy by cutting one or more scleral flap sutures. It was shown that LSL has comparable effectiveness with releasable scleral flap sutures.[62] LSL is an important laser intervention used at early phase of trabeculectomy in eyes where internal ostium is intact and there is deep anterior chamber without bleb formation. Hypotony is a one of the complications that may develop following LSL, which is caused by burn in conjunctiva that forms bleb wall and subsequent loss of anterior chamber due to focal humor aqueous leakage from perforated area (Figure 5a and 5b).

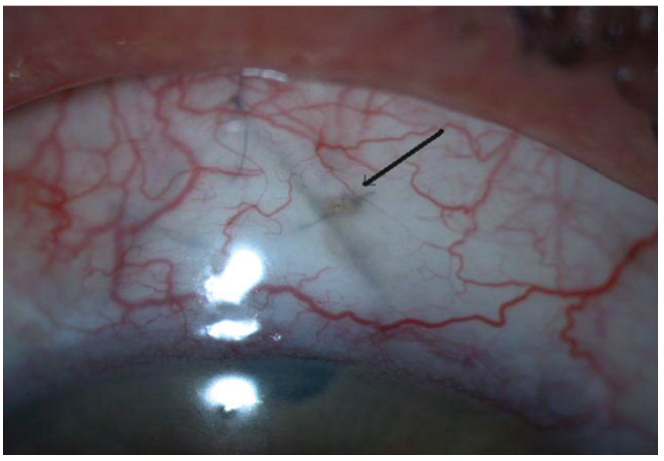

Figure 5a. *Perforation due to conjunctival burn formed during laser suturolysis leads humor aqueous leakage.*

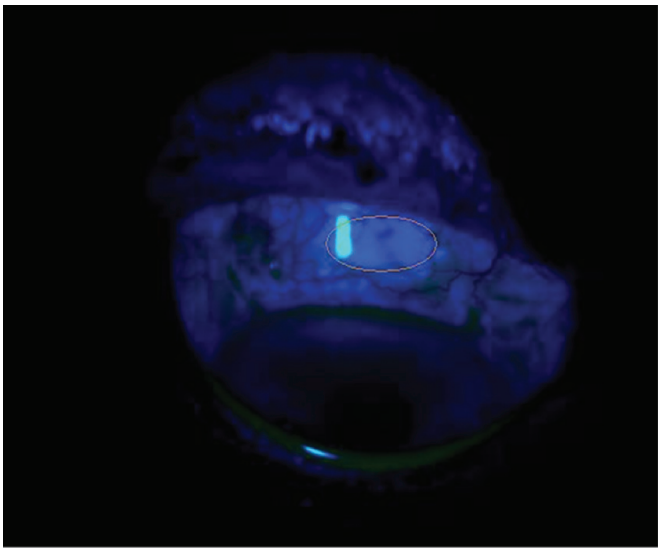

Figure 5b. *Seidel test was positive, anterior chamber was shallow and intraocular pressure was low in this case.*

Cyclodialysis and Hypotony

Hypotony secondary to ciliary body detachment and choroid effusions are seen in several conditions. Pathologies such as proliferative vitreoretinopathy, chronic uveitis or capsule contraction can cause tractional ciliary body detachment.[63-65] In addition, long-term serous ciliochoroidal effusion secondary to prolonged surgical hypotony can also cause ciliary body detachment.[22] In these

cases, cyclodialysis clefts are formed when ciliary body is detached from scleral spur. Thus, an abnormal pathway develops between anterior chamber and suprachoroidal space for humor aqueous efflux, resulting in hypotony.[66] Detachment of ciliary body from natural position disrupts non-pigmented ciliary epithelium and vascular system supplying non-pigmented ciliary epithelium; thus, it leads decreased humor aqueous production. This further aggravates hypotony. In cyclodialysis cases, gonioscopy is challenging due to presence of shallow anterior chamber in addition to hypotony. Viscoelastic substance injection into anterior chamber is recommended to assess angle structures in these cases.[67-69] However, anterior chamber optic coherence tomography (OCT) and ultrasound biomicroscopy (UBM) are currently used as excellent non-invasive imaging modalities.[70] UBM is preferred particularly in the presence of opaque cornea that restricts gonioscopy and anterior segment OCT (Figure 6).[71] Silicone Work Group found that silicone oil tamponade is effective to decrease hypotony incidence.[72] In addition, relieving tractional elements such as membrane dissection and excision or radial anterior capsulotomy also contributes to elevate intraocular pressure.[64,65] Gürelik et al. suggested that majority of cases caused by excessive filtration could respond surgical treatment while there is no effective and definite treatment for ciliary body dysfunction. Authors showed that capsule tension ring implantation to anterior chamber angle increased intraocular pressure in cases having humor aqueous release at some degree.[73]

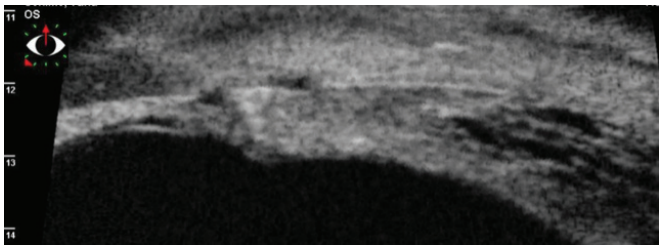

Figure 6. *On ultrasonic biomicroscopy (UBM) image, iris tissue has thin, atrophic and hyper-dense appearance; ciliary body is atrophic with anterior traction and suprachoroidal effusion is seen.*

CONCLUSION

Postoperative hypotony is a relative infrequent complication that can cause loss of vision or eye. It is important to perform a meticulous clinical assessment along with imaging studies in order to reveal underlying condition. In mild cases, supportive treatment and close monitoring can be adequate. However, clinical success warrants identifying and treating underlying physiopathological processes.

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