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Review Article

Glaucoma after open globe injury

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Abstract

Ocular trauma remains a core root of avoidable blindness worldwide. Corneal scarring, lens injury, glaucoma, vitreous hemorrhage, retinal or choroidal detachment and endophthalmitis are sequel to ocular trauma that can lead to blindness. Very few studies have been published to tackle the risk of developing post-traumatic glaucoma after open globe injuries (OGI), however, there are many articles discussing closed eye injury. This review article aims to cover the incidence, risk factors, causes and treatment of glaucoma after open globe injury.

Keywords: Post-traumatic glaucoma, Open globe injury

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Introduction

Glaucoma after OGI should be considered after any ocular trauma. Damage of the optic disk can easily occur due to persistent elevations in intraocular pressure. Despite this fact, each trauma case has its own mechanism that leads to high intraocular pressure, it is therefore important to understand these patterns to predict glaucoma risks and explore the different types of glaucoma that may result. Different types of traumatic glaucoma lie between the open and closed type that reflect the importance of gonioscopy examination. Risk factors of closed eye injuries have been widely discussed but little has been addressed about OGI. The prediction and clinical management of traumatic glaucoma in open-globe injury still remain largely unaddressed in the literature, and persistent IOP elevation remains a significant complication after open-globe injury that often requires attention.[1] Medical treatment is always available and administered, otherwise surgical intervention should be mandatory when IOP is not controlled.

Open globe injury

Globe rupture occurs when the veracity of the external layer of the eye is disrupted by blunt or penetrating trauma. Open globe injury is defined as full-thickness injury to the cornea, sclera, or both.[2] Extent of the open globe injury (cornea only [zone I], corneoscleral within 5 mm of the limbus [zone II], and corneoscleral extending 5 mm beyond the limbus [zone III].[3] OGI is considered an ophthalmic emergency that requires perfect management by an ophthalmologist. More damage to the posterior segment of the eye is allied with a very high rate of permanent visual loss. Well-timed recognition and early intervention are crucial in improving the outcome. Careful follow up of these patients for the possibility of increased IOP and occurrence of glaucoma is necessary.

Incidence of glaucoma

The incidence of glaucoma after open globe injury (OGI) or closed eye injuries is variable. In literature, studies have

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Table 1. Major studies of glaucoma after open globe injury.

	Girkin et al.[5]	Turalba et al.[7]	Osman et al.[11]
F/U	6 months	2–89 months	3 m–13.8 years
No of patients	3627	65	775
Incidence	2.7%	17%	5.3%
Risk factor	– Advancing age – Lens injury – Poor presenting – Visual acuity <20/200 – Intraocular inflammation	– Increased age – Hyphema – Lens injury – Zone II injury	– Advancing age – Poor presenting visual acuity – Perforating rather than penetrating ocular injury – Vitreous hemorrhage – Lens dislocation – Presence of IOFB – Cataract surgery following the primary repair

estimated the incidence rate of closed eye injury to be between 3.4% and 19%.[4] In OGI, few studies have discussed this issue; a cohort study by Girkin et al.[5] with a total of 3627 patients who experienced penetrating ocular injury as the risk of developing post-traumatic glaucoma after repair was 2.7% after 6-month follow-up. In Osman et al.[6] study done at King Abdulaziz University tertiary Hospital in Riyadh with 775 patients after repair of open globe injury, the incidence of post-traumatic glaucoma after repair was 5.3% after a mean follow-up of 12 ± 6.5 months. The longer duration of mean follow-up in the previous study may explain this higher incidence of post-traumatic glaucoma.

Turalba et al.[7] estimated a prevalence of 17% mainly due to ocular hypertension after OGI. According to Turalba's criteria, cases of IOP $\geqslant$ 22 mmHg at one visit treatment were included in the study, and this may have overestimated their prevalence.

It is important for ophthalmologists to educate the patients and primary care providers about the risks of glaucoma after OGI.

Risk factors

Few studies have reported risk factors for glaucoma after open globe injury.

It has been reported in a large study by Girkin et al.[5] that several factors are significantly associated with the development of post-traumatic glaucoma, including advancing age, lens injury, poor presenting visual acuity, and intraocular inflammation. Turalba et al.[7] presented risk factors for developing ocular hypertension after open-globe injury as: Increased age, hyphema, lens injury, and zone II injury. Osman et al.[6] reported significant risk factors for glaucoma as: advancing age ($p = 0.05$), poor visual acuity at presentation, perforating rather than penetrating ocular injury, vitreous hemorrhage, lens dislocation, presence of intraocular foreign body (IOFB) and undergoing cataract surgery following the primary repair.

Contrary to Girkin study, there was no significant association between the presence of retained IOFB and glaucoma, and this may be explained by their protocol of removing IOFB during the primary repair Table 1.

Causes

The causes of traumatic glaucoma are multifactorial depending on the amount and extent of the injured tissue. Numerous potential mechanisms have been raised; it can occur secondary to the disturbance of the trabecular meshwork or inflammatory scarring or stumbling block of the trabecular meshwork by direct inflammation, inflammatory debris, lens particles, coagulated blood components, red blood cells from a hyphema or from long-standing vitreous hemorrhage.[8] Bai et al.[9]divided the causes of ocular trauma related glaucoma into three stages, early, intermediate and late stage; they incorporated closed and open eye injuries of 103 cases. In the previous study at the early stage (1–4 weeks) there were 33 cases due to inflammation, 36 due to hyphema and 22 due to lens dislocation; at the intermediate stage (1–6 months) there were 3 cases due to pupillary block and 2 due to phacoanaphylactic glaucoma and at the advanced stage (more than 6 months), 6 cases were due to angle recession and one case due to siderosis. Milder et al.[10] postulated that the mechanism of traumatic glaucoma may be due to blockage of the trabecular meshwork with inflammatory debris and inflammation that can lead to peripheral anterior Synechiae or due to steroid use, epithelial/ stromal downgrowth and siderosis. De Leon and Girkin[4] encountered an increase in the IOP to trabecular meshwork swelling without hyphema or angle recession. Osman et al.[11] classified ocular trauma glaucoma after OGI into three stages namely early, intermediate, late stage, and contrary to Bai et al. they included open globe injuries cases only. In Osman study,[11] the causes of glaucoma in the early stage are: un-removed lens particles in 11 patients, inflammation in 6 patients and hyphema in 3 patients. In the intermediate stage glaucoma was due to synechial angle closure in 9 patients, in 3 patients due to ghost cell glaucoma, and unremoved lens particles in another 2 patients. In the late stage, 4 patients were affected with glaucoma due to angle recession and 3 patients as a result of synechial angle closure.

Treatment

Prevention still has a role in management of glaucoma after OGI. Viscoelastic material is advised during the repair of OGI to maintain the consistency of the angle of the anterior chamber and prevent the anterior Synechiae. Aggressive treatment is mandatory by frequent topical steroids to suppress the inflammation that can lead to peripheral anterior Synechiae. Bai et al.[9], advised the use of 0.1% dexamethasone eye drop and dexamethasone 0.1–0.2 mg/kg/d through intravenous route for 5–7 days to eyes with inflammation. As regards medical treatment of glaucoma after OGI, Turalba et al.[7] presented 65 patients with ocular hypertension, majority of patients were treated medically (74%) and this may be attributed to their criteria of definition of traumatic glaucoma as an elevation of IOP in one visit or more. Osman et al.[11] had 10 cases (24%) that responded to medications by corticoste-

roid and cycloplegic and the IOP was controlled effectively in all these cases. Surgical intervention plays an important role in management of glaucoma post closed and open globe injuries that is not responding well to medical treatment. Mermuod et al.[12] matched up the success of trabeculectomy in angle recession glaucoma to primary open angle glaucoma and concluded that posttraumatic angle recession is a risk factor for failure of trabeculectomy. Manners et al.[13] study showed trabeculectomy with mitomycin C as an effective surgical procedure for medically uncontrolled post-traumatic angle recession glaucoma with the success rate at final follow up of 77% (33/43 eyes). Turalba et al.[6] had 8 (12%) patients who underwent filtering or glaucoma drainage device surgery, while 4 (6%) required anterior chamber washout with no other glaucoma surgery. Osman et al.[11] resulted in 5 patients with synechial angle closure, 2 cases with persistent hyphema and 2 with lens aspiration that underwent trabeculectomy with MMC surgery with an overall success rate of 100% as of the last follow-up visit assessment.

Glaucoma drainage devices are other options in the management of traumatic glaucoma, Fuller et al.[14] presented 38 patients with traumatic glaucoma treated with Molteno Implant, at the final follow-up, intraocular pressure was controlled in 26 cases and controlled with the addition of hypotensive medication in three cases. Mermoud et al.[15] studied thirty cases of traumatic glaucoma with single-plate Molteno implants, and 56% (17/30) of cases had controlled IOP without topical treatment at mean follow-up of 20 months. Mills et al.[16]study demonstrated a 62% success rate at 44 month follow-up of Molteno drainage devices which included eight cases of traumatic glaucoma. Osman et al.[11] experienced 2 cases of Ahmed valve implant, one with angle recession and one with synechial angle closure with good IOP control at final follow up.

As regards cyclophotocoagulation (CPC) as a modality for treatment of glaucoma, Zhang et al.[17] studied the predictive factors for success across different types of glaucoma treated with CPC in 54 eyes of 54 consecutive patients; a 20.0% success rate was achieved in cases with traumatic glaucoma compared with other types of glaucoma. Iliev and Gerber[18] studied a series of 131 eyes of 127 patients with refractory glaucoma and found that cases with traumatic glaucoma constituted the majority of cases that underwent 3 or more repetitions of CPC intervention. Osman et al.[11] presented, 5 patients (12.2%) received CPC intervention and achieved 20% complete success where 3 patients were controlled with additional anti- glaucoma medications.

Conclusion

Traumatic glaucoma after open globe injury is not uncommon. More prospective studies for glaucoma after OGI with long follow up are needed otherwise it will result in underestimation of the actual incidence percentage. Several baseline risk factors have been identified that are significantly and independently associated with the development of glaucoma, including advanced age, poor visual acuity at presentation, perforating rather than penetrating ocular injury, lens injury, presence of vitreous hemorrhage and presence of an intraocular foreign body. Special attention should be paid to any early signs of glaucomatous changes, particularly in patients who are considered at high risk. Medical treatment is always available; however, uncontrolled cases need early surgical intervention.

Conflict of interest

The authors declared that there is no conflict of interest.

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