



Causes and Managements of Early-Onset Ocular Hypertension Following Pars Plana Vitrectomy with Silicone Oil for Retinal Detachment and Exploration of Trabeculectomy as a Viable Alternative Management: A Pilot Study

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ABSTRACT

Introduction: This study aims to study a relatively unexplored topic about the causes and managements of early-onset ocular hypertension (OHTN) following the pars plana vitrectomy with silicone oil (PPV with SO) procedure for retinal detachment. Additionally, to explore the outcome of trabeculectomy in managing such patients.

Materials and methods: This is a retrospective exploratory pilot study. We studied 23 patients who underwent the procedure then subsequently developed ocular hypertension within a month of the procedure. The probable causes for their early-onset ocular hypertension were identified and addressed with medicine, peripheral iridotomy (PI), complete or partial silicone removal. Trabeculectomy was done in irretractable causes. This study aimed to evaluate the causes of early onset ocular hypertension after pars plana vitrectomy with silicone oil and explore the outcome of different managements including trabeculectomy.

Results: Inflammation (n=11, 47.8%) was the most common cause of early-onset ocular hypertension. Other causes were overfilling/spilling of silicone oil in anterior chamber (n=5, 21.7%), pupillary block (n=4, 17.4%) and angle-recession glaucoma (n=2, 8.69%). Majority of the cases responded to intraocular pressure (IOP) lowering medications (n=11). Three eyes with persistently high intraocular pressure underwent trabeculectomy after which the intraocular pressure was controlled.

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Conclusion: Even though prior studies have reported that trabeculectomy does not address late-onset ocular hypertension, our study shows that the procedure might be helpful in early-onset ocular hypertension. This is probably because at the time of presentation for early-onset ocular hypertension, silicone has not emulsified, which will not be the case in late-onset ocular hypertension. If a large study also shows that trabeculectomy can correct early-onset ocular hypertension, this information can guide the practices of ophthalmologists whose patients cannot afford expensive glaucoma drainage devices.

Key words: Intraocular pressure, Glaucoma, silicone oil, Trabeculectomy.

INTRODUCTION

Pars plana vitrectomy (PPV) with silicone oil (SO) is done to correct retinal detachment (RD). Increase in the intraocular pressure (IOP) is a feared postoperative complication- which can manifest at any time with symptoms ranging from mild and transient to severe and permanent vision loss.(Al-Jazzaf AM et al, 2005; Han DP, Lewis H, Lambrou FH Jr, et al, 1989; Honavar SG, Goyal M, Majji AB, et al, 1999; Ichhpujani P, Jindal A, Katz JL,2009; Nguyen QH, Lloyd MA, Heuer DK, et al, 1992) Various risk factors have been identified for this complication. SO emulsification is the most common risk factor of the late-onset ocular hypertension (OHTN). (Kornmann HL, Gedde SJ.,2016) The early-onset OHTN is mainly thought to be caused by inflammation and fibrin formation in and around the anterior chamber(Han DP, Lewis H, Lambrou FH Jr, et al. 1989). However, SO over filling, migration of SO into the anterior chamber, and pupillary block are among the other common causes.(Budenz DL, Taba KE, Feuer WJ, et al. 2001)

Prompt management of increased IOP is needed to avoid optic nerve atrophy and blindness. Several studies conducted on patients who developed late-onset OHTN suggested- good outcomes with antiglaucoma medicine.(Al-

Jazzaf AM, Netland PA, Charles S. 2005; Costarides AP, Alabata P, Bergstrom C. 2004; Han DP, Lewis H, Lambrou FH Jr, et al. 1989) However, managing patients who have increased IOP immediately after the surgery or within a month of the surgery is challenging and not many studies have explored this arena. In the case of an early-onset OHTN unresponsive to medical management, partial or complete silicone oil removal (SOR) may need to be considered.(Han DP, Lewis H, Lambrou FH Jr, et al. 1989; Honavar SG, Goyal M, Majji AB, et al.1999; Moisseiev J, Barak A, Manaim T, et al.1993; Nguyen QH, Lloyd MA, Heuer DK, et al. 1992) If a surgeon is concerned of retinal detachment following SOR, use of a glaucoma drainage device (GDD) is an alternative procedure, but its high cost and low availability in resource poor countries limit its accessibility. (Rateb et al., 2019)

A relatively unexplored, potential treatment to address early-onset OHTN is trabeculectomy, which is an affordable and easy-to-perform procedure. However, studies that look at the effectiveness of trabeculectomy for late-onset OHTN have not found it useful.(Errico D, Scrimieri FL, Riccardi R, Iarossi G. 2016) Nevertheless, it is our hypothesis that failure of trabeculectomy in late-onset OHTN is related to



silicone emulsification and pre existing scarring of the conjunctiva. Therefore, the procedure might benefit patients without encircling bands and with early-onset OHTN as silicone oil has not yet emulsified.

In this pilot study, we investigated an underreported topic of early-onset ocular HTN. We explored the reasons to develop the condition following PPV with SO for RD. We also studied the outcome of trabeculectomy as a treatment modality along with other treatment alternatives such as IOP lowering medicines, Nd:YAG peripheral iridotomy (PI), and partial and complete silicone oil removal.

MATERIALS AND METHODS

The study received ethical clearance from the institutional review board of Birat Medical college and teaching hospital, Nepal and strictly adhered to the tenets of the Declaration of Helsinki. Cases from March 2019 to November 2019 were retrospectively studied. The inclusion criteria were: the person should have undergone the PPV with SO for RD during the study period, presented to the hospital for OHTN within a month of undergoing PPV, and completed at least 3 months of follow-up after their IOP was controlled. The exclusion criteria were: someone who underwent PPV with SO with encircling band, presented to the hospital for OHTN after a month of undergoing PPV, or had known risk factors to increase IOP (such as a history of any type of glaucoma or undermedicated for glaucoma, OHTN before RD surgery, chronic topical steroid use, and anterior synechiae). A total of 23 eyes were identified that fit the study criteria.

Prior to the surgery for retinal detachment, all patients had a baseline examination of the best-corrected visual acuity, dilated fundus examination, and Goldmann applanation tonometry. Then, they underwent 23-gauge, three-port PPV (Associate 6000, DORC, The Netherlands) with SO instilment (SO-1000 centistokes, Aurolab, India) in the vitreous chamber.

Topical Brimonidine 0.2%-Timolol 0.5% (Combigan, Allergan) was used twice daily as the IOP-lowering medication until the next followup. Patients who required Nd:YAG Peripheral Iridotomy (PI) (Q-switched Nd-YAG 1064nm, YLC 200, Nidek, Japan), underwent the procedure with standard protocol. Patients who underwent partial silicone removal had approximately 0.75–1ml of the silicone oil removed via pars plana route using two 23G, standard-valved trocars (Associate 6000, DORC, The Netherlands). For complete SOR, it was done as per the standard practice. Patients who had sustained OHTN despite complete SOR underwent trabeculectomy after 1-month grace period for observation with medical treatment.

Surgical procedure for trabeculectomy with Mitomycin-C(MMC) 0.02%

After painting and draping with 10 % povidone iodine, universal eye speculum was applied. Corneo-limbal stay suture was placed at 12 o'clock position. Then, the conjunctival dissection was done meticulously and a fornix-based conjunctival flap was made. Hemostasis was maintained with bipolar cautery. Surgical sponge soaked in 0.02% MMC was placed between sclera and conjunctiva for 2 minutes.

After the sponge was removed, thorough irrigation was done with Ringer's lactate. Next, a triangular scleral flap (3mm x 3mm x 3mm) was made and dissected towards the clear cornea. A deep scleral ostium was created using Kelly's Punch and peripheral iridectomy was performed. The scleral flap was closed with one interrupted suture (nylon 10-0) at the apex of flap. Additional sutures at the base of the triangular flap were placed when appropriate. The conjunctival flap was closed with mattress sutures with 8-0 Vicryl. The stay suture was removed and subconjunctival injection of dexamethasone 2mg and gentamicin 20mg was applied in the inferior fornix.

Post operatively, slit lamp examination was done to evaluate the surgical outcome and the IOP. Eye drops Atropine 1% one drop three times a day, prednisolone acetate 1% one drop four times a day, and ofloxacin 0.3% one drop four times a day were prescribed for two weeks. Patients were asked to follow up in two weeks.

During the follow-up, IOP was evaluated. If the pressure remained high (>21mmHg) IOP-lowering medicine was added. The patient was asked to come back again in two weeks. The same was repeated in subsequent visits. If it remained high or the patient presents prior to two weeks with a complaint associated with high IOP, we tried to manage it with PI.

In eyes which had "push mechanism" angle closure or if silicone oil was found communicating with the anterior chamber, the eyes were planned for silicone oil removal. Eyes with more than one breaks, with proliferative vitreoretinopathy of grade B or greater and

detachment involving the macula underwent partial SOR. Others eyes underwent complete SOR.

For a treatment modality to be considered successful in managing OHTN, the patient needed to have a normal IOP (lower than 21 mmHg) for at least 3 months.

RESULTS

The sample size consisted of 23 patients. Most of them were male (n=17). Their mean age was 37.3 years (5.98SD) and the mean IOP was 34.5 mmHg (7.60SD).

Trauma (n=9) was the most common mechanism of retinal detachment, followed by non-myopic degenerative changes (n=7). The majority of the patients were phakic (n= 13). The demographic information, clinical profile, and distribution of the eyes according to the lens status and mechanism of RD are illustrated in Table 1.

Reactionary or inflammatory reaction (n=11) was found to be the most common cause of early-onset OHTN, followed by probable overfilling of SO (n=5). Angle recession (n=2) was the cause exclusively found in trauma patients.

Clinical findings also varied according to the lens status. Inflammatory reaction (8/11) was the most common finding in the phakic eyes; whereas, pupillary block was the most common cause in aphakic eyes (n=4). Probable overfilling was comparable in all groups. The overall distribution of the findings is illustrated in Table 2.

Once the early-onset OHTN was diagnosed, in terms of its management, IOP-lowering

Table 1: Demographics, clinical profile and lens status of the patients.

Number of patients	23		
Mean Age (SD) in years	37.3(5.98)		
Male : Female	17:6		
Mean IOP (in mmHg)	34.5mm Hg(7.6)		
	Lens status at the time of OHTN		
Mechanism	Phakic	Posterior chamber intra-ocular lens	Aphakic
Trauma	4	1	4
Secondary to degenerative changes(Non myopic)	5	2	-
Secondary to degenerative changes(myopic)	3	3	0
Idiopathic	1	-	-

medication and partial SOR successfully lowered the IOP in 47.8% (11/23) and 13.0% (3/23), respectively. Complete SOR was done in 21.7% (n= 5/23) but IOP became normal in only two eyes. The remaining three eyes underwent trabeculectomy, following which all the eyes had normal IOP.

The analysis of management according to the

cause of retinal detachment showed that early-onset OHTN in trauma patients was least likely to respond to IOP-lowering medication. Three of the cases of OHTN who had a history of trauma required trabeculectomy with MMC (0.02%) to address their high IOP. Two of these cases had an angle recession. Table 3 provides the summary of the management.

Table 2: Various causes of early-onset OHTN post PPV with SO distributed according to the reasons behind retinal detachment and patients' lens status.

Mechanism and clinical finding	Reactionary / inflammatory (with or without fibrin)	Probable overfilling of silicone oil / silicone Oil in AC	Pupillary block	Angle recession glaucoma
Trauma	2	4	-	3
Secondary to degenerative changes (non-myopic)	4	1	2	-
Secondary to degenerative changes (myopic)	4	-	2	-
Idiopathic	1	-	-	-
Lens status and clinical finding				
Phakic	8	2	1	2
Posterior chamber intraocular lens	3	2	-	1
Aphakic	-	1	3	-

Table 3: Distribution of the management of early-onset OHTN with respect to the mechanism of RD.

	IOP lowering medications	Peripheral Iridotomy	Partial silicone oil Removal	Complete silicone oil removal	Trabeculectomy with MMC 0.02%
Trauma	2	-	3	1 + (3*)	3*
Secondary to degenerative changes (Non- myopic)	4	2	-	1	-
Secondary to degenerative changes (myopic)	4	2	-	-	-
Idiopathic	1	-	-	-	-

(* Number of cases in which complete SOR was performed but IOP remained high and needed trabeculectomy)

DISCUSSION

SO is widely used as a surgical tamponade and vitreous substitute in retinal detachment repair. (Tranos P et al, 2004) Ocular hypertension and secondary glaucoma are two of the most serious complications—with the incidence of the latter ranging from 11 -56% (Ho T, Fan R,1992; Honavar SG, Goyal M, Majji AB et al,1999)

Various studies have explored the mechanisms of increased IOP post PPV with SO. (Al-Jazzaf AM, Netland PA, Charles S, 2005; Budenz DL, Taba KE, Feuer WJ, et al,2001;Tranos P et al, 2004; Weinberg RS, Peyman GA, Huamonte FU,1976) . Weinberg et al has reported that an increased IOP after PPV without SO was mainly due to neovascularization, hemorrhage, hemolysis, and phacolysis.(Weinberg et al., 1976) Nguyen et al(Nguyen QH, Lloyd MA, Heuer DK, et al. 1992) observed that emulsified silicone oil enters the anterior chamber, which might impede the drainage of aqueous humor through the trabecular meshwork due

to silico-macrophagocytosis. In addition, Watzke(Watzke, 1967) indicated that despite rising IOP, visible oil might be absent in the anterior chamber.

However, most of these studies only studied elevated IOP in late-onset OHTN, which was likely affected by silicone oil emulsification. For eyes presenting with OHTN within a month of PPV, IOP elevation is mainly due to trabeculitis and membrane inflammation, pupillary block or due to a presence of peripheral anterior synechiae(de Corral et al., 1987). These are often reversed by IOP lowering medication. (Costarides AP, Alabata P, Bergstrom C. 2004;Kornmann HL, Gedde SJ. 2016)

Findings from our study also suggested the same. Most of the cases had an underlying inflammatory reaction and the majority of them responded well to IOP-lowering drugs. Interestingly, an inflammatory reaction was observed more in phakic eyes. It is a well-established fact that cytokine levels increase

after any ocular surgery,(*Garweg, J.G et al, 2019;*) but we are unable to explain the difference in the degree of inflammation between phakic and aphakic eyes. None of the eyes had any visible lens trauma, subluxation or cataractogenesis on slit lamp examination to account for the difference. We speculate that microscopic damage to the lens during the RD surgery -could be responsible for mediating an enhanced inflammatory cascade in phakic eyes. This however needs confirmation as our follow ups were limited to approximately 3 months and none of the eyes developed any lens related complications – e.g. Cataractogenesis - during that period.

Most of the pupillary blocks in early-onset OHTN were found in aphakic eyes. A ball valve mechanism of the SO at the pupil with formation of iris bombe is a well-established phenomenon. (*Ho T, Fan R. 1992; Zalta AH, Boyle NS, Zalta AK. 2007*) Nd:YAG PI was successful in normalizing IOP in all of the eyes. It has been established that Nd:YAG PI inferiorly relieves pupillary blocks by bypassing the aqueous flow with a high success rate.(*Zalta AH, Boyle NS, Zalta AK. 2007*) In our case, none of the eyes required further laser treatment.

None of the eyes that underwent either partial or complete silicone oil removal had re-detachment. Eyes that received partial SOR responded well to the intervention; they did not require further management to control the IOP. However, complete SOR failed to control the high IOP in three eyes. The role of SOR to control IOP in late-onset OHTN is still a contested topic as the information about the success rate vary

widely.(*Han DP, Lewis H, Lambrou FH Jr, et al. 1989; Ichhpujani P et al, 2004*) Similarly, to the authors' best knowledge, there is no prior literature comparing the effectiveness of SOR in early-onset OHTN. Hence, future studies to compare outcomes of partial vs. complete SOR in the management will be valuable in better understanding their therapeutic potential.

Three of the eyes with persistently high IOP despite SOR had histories of trauma. Angle recession (AR) was noted in two and the cause for OHTN could not be identified in the third case.

The incident of AR has been reported as early as a month after trauma(*Kaufman JH, Tolpin DW. 1974; Salmon JF et al , 1994*) However, based on the standard protocol for normal IOP, none of our patients underwent gonioscopic examination prior to the RD surgery. While we believe that the eyes with AR might not have increased IOP due to shunting of intraocular fluids via the retinal break into the subretinal space, the finding also highlights the importance of presurgical gonioscopy. Patients with features of AR should be identified and notified regarding the importance of close monitoring and a possibility of further surgery to control their IOP.

Three eyes that received trabeculectomy with MMC 0.02% for persistently high early-onset OHTN despite other interventions, remarkably, responded to the procedure, lowering the IOP. Although trabeculectomy combined with intraoperative metabolite has established itself as one of the most preferred surgery for AR

related glaucoma,(*Mermoud A et al, 1993; Salmon JF, et al, 1994*) there is very limited information on its outcomes in eyes that have undergone PPV with SO.

Usually a glaucoma drainage device (GDD) is preferred as a last resort for post vitrectomized eye with OHTN. However, its recommendation is derived from studies that analyzed cases of late-onset OHTN which have patients with emulsified silicone oil. (de Corral et al., 1987; *Costarides AP et al, 2004; Errico D et al, 2016; Han DP et al, 1989; Honavar SG et al. 1999; Laroch L et al, 1983*) Studies have shown a presence of silicomacrophagocytic inclusion in the trabecular meshwork of eyes with OHTN due to emulsified silicone oil. Furthermore, it has been concluded that trabeculectomy in such eyes is difficult and the risk of failure is also high due to the presence of macrophages and inflammation in internal ostium.(*Errico D et al , 2016*) Thus, we theorized that if trabeculectomy is performed in eyes without significant conjunctival scarring (e.g.:larger vitrectomy ports or encircling band) and signs of emulsified SO, it can be a viable surgical procedure to control IOP in early-onset OHTN.

CONCLUSION

Understanding the mechanism of increased IOP is a key to its successful treatment. Elevation occurring in the early-onset OHTN post PPV with SO is mainly associated with inflammatory reaction and more common in phakic eyes. Majority of the eyes can be controlled by IOP lowering medications. Pupillary block must be considered in aphakic eyes and Nd-YAG PI

is successful in treating such cases. Partial or Full SOR may be performed in selective cases with minimal risk of detachment. However, their outcomes are less predictable—mandating a closer follow-ups and analysis of risk factors that can result in poor outcomes.

AR may have a normal presurgical IOP and elevated postsurgical IOP. Gonioscopy can be helpful in pre-surgical investigation of eyes with prior trauma to identify AR.

Trabeculectomy might play an important role in early-onset OHTN following PPV with SO to successfully treat ARG or uncontrolled IOP, especially in developing countries where patients cannot afford expensive GGD. Conjunctival scarring and emulsified SO could be the reason behind poorer outcomes of trabeculectomy in late-onset OHTN.

Recommendations

All the patients who eventually needed trabeculectomy in our study, successfully got their OHTN controlled after the procedure. However, we acknowledge that our sample size was small. If the outcome of trabeculectomy in controlling early-onset OHTN following PPV for RD with SO can be studied in a large sample, we believe that the outcome of trabeculectomy can be analyzed better. This finding will have a potential to change the protocol of how ophthalmologists around the world address early-onset OHTN following this surgery that are unresponsive to other management.



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