

Literature Review

Phacoemulsification in High Myopia with Silicon Filled Eye

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ABSTRACT

High myopia is a pathologic condition which has different anatomy from emmetropic eyes. The elongated vitreous chamber were increasing the shear stress of vitreous and retina, giving risk to several vitreoretinal disorders especially retinal detachment (RD). The extensive and complicated RD that happened in high myopic eyes make pars plana vitrectomy with silicon oil (SO) tamponade more preferable. Unfortunately, treatment of RD in high myopic eyes, especially with SO increase the incidence of cataract. The incidence of cataract in SO filled eyes is nearly 100% if the SO remains for several times. This paper reviews these issue, presenting the way to treat cataract in high myopic SO filled eye effectively with combination of phacoemulsification and SO removal with IOL implantation, helped with the usage of IOL Master.

Keywords: *phacoemulsification, high myopia, silicon filled eye*

High myopia is defined by having myopia with a spherical equivalent (SE) of -6.00 Diopter (D) or worse and / or having axial lengths (AL) higher than 26.5 mm.¹ Although milder degree of myopia is the most common ocular abnormality and one of the major cause of visual impairment in the world, high myopia has much lower prevalence.² There are many factors that influence the incidence of high myopia such as ethnic groups and races, but the incidence was higher in Asian population than Caucasian.¹⁻⁴

The anatomy of the vitreous chamber in high myopic eyes is different from the emmetropic eyes. In the emmetropic eyes the anteroposterior AL is shorter than the vertical and horizontal axes, while in high myopic eyes the anteroposterior AL is longer than those two axes.² This condition is pathologic that the elongated vitreous chamber may increase the shear stress of the vitreous and the retina,⁵

thus making it prone to vitreous and retinal degeneration, liquefied vitreous, posterior vitreous detachment (PVD), lattice degeneration and more importantly retinal breaks that subsequently lead to retinal detachment (RD).^{1,2}

The incidences of retinal detachment in high myopic eyes are higher than the emmetropic eyes. This condition increases the needs of vitreoretinal surgery for the RD as it may cause permanent damage to the retina. Additionally, internal tamponade, such as silicone oil (SO), is frequently used in conjunction with the surgery. But these two procedures might cause cataract⁶ which pose another problem in the high myopic eyes.

Vitreoretinal Surgery in High Myopic Eyes with Retinal Detachment

Retinal detachment is a common complication of high myopic eyes. Retinal detachment is an ocular emergency; hence surgical intervention is

needed to prevent permanent visual impairment or blindness. However the prognosis of RD in high myopic eyes is poor because of the diversity of the lesions. The shear stress on the vitreous and the retina cause the RD to be extensive and complicated. The breaks or tears are usually more posterior in these eyes compared to the breaks or tears that occur in the emmetropic eyes. Moreover, macular holes are common in this eyes.² These features make the RD in high myopic eyes difficult to treat

There are many methods to treat RD nowadays, but the common treatments are scleral buckling, pars plana vitrectomy and pneumatic retinopexy. The closing of the retinal breaks is achieved by tamponade, either external tamponade in the scleral buckling using explant or internal tamponade in pars plana vitrectomy using intraocular gas or SO that is administered at the end of the procedure.²

Pars Plana Vitrectomy with Silicone Oil Tamponade. Among all of these procedures, pars plana vitrectomy is getting more popular as the primary repair of RD in the high myopic eyes, especially in the pseudophakic eyes², due to the difficulties of the scleral buckling in these high myopic eyes and the unpredictable outcome of the pneumatic retinopexy⁷. The extensive and complicated RD that happened in high myopic eyes also made pars plana vitrectomy more preferable. Pars plana vitrectomy is done by removing the vitreous, directly reattaching the retina using perfluorocarbon liquid and sealing the breaks with endolaser photocoagulation. At the end of the procedure, internal tamponade agent is administered to prevent fluid seepage and allow sufficient time for the retina to reattach following the endolaser photocoagulation.²

Internal tamponade that is frequently used are gas mixture or silicone oil (SO). Silicone oil is more popular due to its advantages, including faster recovery time with acceptable return of visual function, shorter duration of prone positioning which provide more comfort to the patients and the hyperopic shift caused by the SO properties which reduce the myopia of the patients.^{2,8}

Overall, the whole procedure yields good success rates, especially when combined with

internal limiting membrane (ILM) peeling.^{2,9} Wolfensberger et al.¹⁰ further reported that the treatment of RD by pars plana vitrectomy combined with SO tamponade and laser photocoagulation resulted in 91 % success rate of anatomic result, though the functional outcome was still ambiguous. However, some complications are associated with vitreoretinal surgery, especially when SO tamponade is used, such as sub capsular cataract, glaucoma and keratopathy.⁶

Cataract Formation after Vitreoretinal Surgery

Scott et al.¹¹ proposed that retinal detachment eyes are predisposed to cataract. The mechanisms of cataract formation in RD eyes include posterior migration of equatorial and anterior epithelial cells and metaplasia of these cells. Furthermore the cells will undergo cytoplasmic vacuolation leading to the destruction of these cells that subsequently ceased the normal lens fiber production.¹¹

Additionally, the treatment of RD through vitreoretinal surgery often causes cataract. Tamponade with SO also increase the incidence of cataract in the surgery.^{6,12} Borislav¹² reported that cataract was common in patients who underwent pars plana vitrectomy with SO tamponade due to the direct contact of between posterior capsule and the SO which cause the inhibition of lens metabolism. The incidence of cataract in silicone filled eyes is nearly 100 % if the SO remains in situ for more than 3 months.¹³ Even when the SO is removed, cataract might develop in up to 60 % of these eyes.¹³

Treatment of Cataract in High Myopic Silicon-Filled Eyes

To treat cataract in eyes filled with SO, several methods had been developed. Formerly, the procedure of cataract extraction, SO removal and intraocular lens (IOL) implantation is done by two separate sessions; either the cataract extraction and SO removal first followed by the IOL implantation latter or the cataract extraction when the SO was administered followed by the SO removal with IOL implantation at a later date.¹³

One session procedure of cataract extraction and SO removal was first introduced by Baer et al.¹⁴

Until now, several methods of combined procedure for cataract extraction and SO removal with IOL implantation have been studied and provide good results.^{13,15} To achieve best refractive outcome after surgery, pre-operative biometric measurement must be done to calculate the power of IOL needed. However, in SO filled eyes, especially when high myopia is also present, the calculation of IOL power through biometric measurement will be difficult and prone to error.^{16,17}

Biometric Measurement

The success in visual improvement of cataract extraction with IOL depends on the accuracy of biometric measurement and IOL power calculation. In high myopic eyes or SO filled eyes, however, accurate pre-operative biometric measurement is difficult to obtain. Axial length, anterior chamber depth (ACD) and keratometric value (K) are essential for making a precise IOL power calculation.¹⁸ Highly myopic eyes might cause error in AL measurement because of the posterior staphyloma.¹⁷ While the SO filled eye pose problem due to the optical and sound attenuation properties of SO.¹⁶ These SO properties making erroneous result when the biometric measurement is done with the conventional ultrasound biometry (A-scan immersion biometry) because of the false longer AL from the sound attenuation, error in measurement from multiple fluid interfaces and poor penetration of sound due to the absorbed sound by the SO.^{16,19} These difficulties will be more apparent if the examiner is not skilled and experienced.¹⁶

To solve the problems in high myopic eyes and / or SO filled eyes, non-contact laser interference biometry (IOL Master) may be used. This techniques uses the method of partial coherence interferometry to measure the AL that is based on the reflection of the interference signal of the retinal pigmented epithelium (RPE).¹⁶ IOL Master is reported to be 10 times more accurate in the phakic emmetropic eyes and performed better in high myopic or SO filled eyes than A-scan immersion biometry.¹⁶ The disadvantages of IOL Master are it is impossible to perform in eyes with dense media opacity, it is hard to perform if the patients have poor fixation and that the device is not widely available.

Recent study by Shen et al.¹⁷ showed that IOL Master provided better result and better repeatability and interchangeability than the A-scan immersion biometry in high myopic eyes. Kunavisarut et al.¹⁶ reported IOL Master had more accuracy and less deviation compared to the A-scan immersion biometry in SO filled eyes. The study also showed that IOL Master provided acceptable result in all eyes with various AL. Thus IOL Master is a recommended technique to use in high myopia and / or SO filled eye that will undergo cataract extraction surgery.

As for the formula used to calculate the IOL power, Wang et al.¹⁸ reported that Haigis formula was superior than Hoffer Q, Holladay 1 and SRK/T in high myopic eyes. The better accuracy was possibly because of the inclusion of the ACD that can be measured by IOL Master.^{18,20} However, Wang et al.¹⁸ also concluded that both Haigis and SRK/T still provided comparable accurate IOL power calculation in the high myopic eyes.

Phacoemulsification with Silicone Oil Removal

For the patients whose eyes are highly myopic and filled by SO, cataract extraction and the SO removal can be done either through one session or two session procedure. Baer et al.¹⁴ first introduced the one session procedure by doing extra capsular cataract extraction (ECCE) with SO removal in a case series though in that study he did not treat all of the patients with one session procedure. As phacoemulsification is widely used cataract extraction surgery today, the one session procedure with phacoemulsification is developed as this method is more time conserving. However not all cases should be treated with one session procedure, especially if the patients have macular pucker, retinal proliferation or unstable retina.¹⁵

Larkin et al.¹³ reported that combination phacoemulsification and SO removal via posterior capsulorhexis generally yielded good outcome with 91 % eyes showed stabilized or improved vision. However recurrent RD occurred in 32 % of the eyes. The SO removal was done through pars plana sclerotomy. Dada et al.¹⁵ also reported that combined phacoemulsification and SO removal through a posterior capsulorhexis

provided similar good outcomes, though in his study the complication such as recurrent retinal detachment occurred less. Nevertheless, the posterior capsulorhexis might cause problem in the IOL implantation. If the posterior capsulorhexis is too large, it may preclude in-the-bag IOL implantation or lead to posterior IOL displacement into the vitreous cavity.¹⁵ In addition, after SO removal, SO bubble might remain in the eye and could adhere to the silicone IOL.²¹ Therefore it is recommended to use foldable acrylic or PMMA IOL so it can be placed in the posterior chamber.¹⁵ The advantages of this technique are that it is time conserving, the incision needed is minimal and the incidence of secondary cataract is prevented because of the posterior capsulorhexis. Overall this combined procedure yields good visual outcomes with minimal complication if the cases are selected correctly and the procedure is done properly.

CONCLUSION

Cataract in high myopic SO filled eyes can be treated by combination of phacoemulsification and SO removal with IOL implantation as this procedure is safe, effective and time conserving. Best visual outcome can be achieved by pre-operative biometric measurement using partial coherence interferometry (IOL Master) because this method is more accurate to calculate IOL power needed in high myopia and SO filled eyes.

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