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# Intraoperative biometry for intraocular lens (IOL) power calculation at silicone oil removal

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PURPOSE. *Cataract development is common following retinal detachment surgery that necessitates silicone oil injection. Intraocular lens (IOL) power calculation in the presence of silicone oil is challenging for many reasons. The authors evaluated the accuracy of intraoperative biometry during cataract surgery in silicone-filled eyes.*

METHODS. *Twelve cases of cataract in eyes filled with silicone oil after retinal detachment surgery were included. Preoperatively, keratometric readings were documented. Intraoperative axial length was measured following removal of silicone oil using a sterile probe of the Nidek Echoscan US800 unit. IOL power calculation was computed using the SRK/T formula. This was followed by phacoemulsification and foldable lens implantation. Postoperative refraction allowed evaluation of the accuracy of intraoperative biometry. The predictability of three different formulas was also compared (Holladay, SRK/T, and SRK II).*

RESULTS. *Seven men and five women with a mean age of 50.2 years were included in the study. The mean postoperative spherical equivalent using the described technique was 6.77 ± 0.43 diopters. SRK/T and Holladay formula had the best predictability for high axial length eyes, whereas the three studied formulas showed no significant differences in predictability in eyes with normal axial length.*

CONCLUSIONS. *Intraoperative biometry proved to have good predictability for the absolute postoperative refractive error in cataract surgery for eyes at the time of silicone oil removal. This predictability was accurate independent of axial length. (Eur J Ophthalmol 2003; 13: 622-6)*

KEY WORDS. *Axial lens measurement, Biometry, Intraocular lens implantation, Intraoperative biometry, IOL power calculation, Silicone-filled eye, Silicone oil removal*

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## INTRODUCTION

The development of cataract is probably the most common complication in phakic eyes following silicone oil injection. In some of these eyes, the potential visual acuity is good enough to warrant cataract extraction and intraocular lens (IOL) implantation. Measuring the axial lens of an eye filled with silicone oil is difficult (1-3). Furthermore, use of the documented axial length of these eyes before silicone oil injection for IOL power calculation may be erroneous because an encircling buckle is applied in most of these cases, and sometimes a segmental buckle is used. Both of these may lead to significant elonga-

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tion of the original axial length resulting in a myopic shift (4, 5).

Because it is desirable that silicone oil will eventually be removed from the eyes, we adopted a new technique of IOL power calculation in which the axial length is measured intraoperatively after silicone oil removal.

## MATERIALS AND METHODS

Our study included 12 phakic eyes of 12 patients. All patients had undergone retinal detachment surgery with an encircling buckle, vitrectomy, and silicone oil injection, and subsequently developed significant lenticular opacities that warranted cataract extraction.

Keratometric measurements were taken using the Nidek KM 450 before starting the surgery.

On the operating table, the following steps were followed successively. An infusion cannula was applied down and temporal 3 mm from the limbus and fixed with 5/0 Dacron suture. An oversized temporal sclerotomy was then made for egress of silicone oil and silicone oil was removed from the eye. After complete removal of silicone oil, the sclerotomy was closed. The lower temporal infusion cannula was kept in place throughout the procedure. The height of the infusion bottle was 40 Cm in all cases.

The axial length was measured using a sterilized probe of the Nidek (Echoscan US 800) unit. This was done while the irrigating fluid was running through the lower temporal cannula (Fig. 1) to maintain the globe configuration and avoid fallacious axial length measurement. The IOL power was then computed using the SRK/T formula.

A standard phacoemulsification with in-the-bag implantation of an acrylic foldable lens was then performed. Following the conclusion of surgery, the lower temporal cannula was removed.

Postoperatively, the patients were followed after 1 week, 2 weeks, and then monthly for 3 months until stabilization of the postoperative refraction.

When checking the patient data, we noticed that six of the operated eyes had high axial lengths from 26.44 to 29.9 mm and the other six eyes were within the normal range from 21.70 to 23.59 mm of axial length. Therefore, we divided the 12 eyes into two separate groups based on axial length.

We evaluated the accuracy of our technique of

**Fig. 1 -** *Intraoperative biometry using sterile probe of Nidek Echoscan US 800, with lower temporal infusion cannula 3 mm from the limbus with the height of infusion bottle 40 cm after removal of silicone oil.*

intraoperative biometry by determining the mean actual postoperative refractive error of each patient. We also used the obtained data to compare the predictability of three different formulas – Holladay, SRK/T, and SRK II – by using the following equation:

Predictive error of each formula in a particular eye = predicted postoperative error by that formula for the IOL – actual postoperative spherical equivalent of the refractive error.

## RESULTS

The study included 12 eyes of 12 patients (7 men and 5 women) with age ranging from 25 to 65 years (mean 50.2 ± 11 years). Using our technique of IOL power calculation, the mean postoperative refractive error (spherical equivalent) was 0.77 ± 0.34 diopters. The axial length ranged from 26.44 to 29.9 mm (mean 28.51 ± 27 mm), the implanted IOL power ranged from 4 to 11.5 diopters, and the spherical equivalent of the postoperative error ranged from +1.0 to -1.12 diopters (mean ±0.77 ± 0.25 diopters) (Tab. I).

By comparing the predictability of the three chosen formulas in this group of eyes, we found that both Holladay and SRK/T formulas had the least error in prediction of postoperative refraction. The predictive error of Holladay formula was 0.42 + 0.28 diopters; that of SRK/T was 0.4 ± 0.4 diopters, with no statistically significant difference between the formulas. On the other hand, SRK II formula showed a statistically higher value of mean predictive error (1.86 ± 0.67 diopters) and the widest range of predictive error (+2.8 to -1.9 diopters). It was also noticed that SRK II formula showed a significant tendency toward overprediction in all of the eyes except in one case (Case 6, Tab. I). By revising the data of this particular case, the K-reading was found to be very low (38.5 diopters).

Table II shows the data of eyes within the normal range of axial length. The axial length ranged from 21.70 to 23.59 mm (mean 22.68 ± 0.72 mm), the implanted IOL power ranged from 19 to 25.5 diopters, and the spherical equivalent of the postoperative error ranged from +1.0 to -1.5 diopters (mean 0.77 ± 0.44 diopters).

Comparing the predictability of the three chosen formulas, all formulas showed small predictive postoperative refractive errors without a statistically significant difference in the predictive errors of the three formulas (Holladay: 0.75 ± 0.52 diopters, SRK/T: 0.73 ± 0.45 diopters, SRK II: 0.59 ± 0.67 diopters).

**TABLE I -** DATA OF PATIENTS WITH HIGH AXIAL LENGTH

| Number | | | Axial length, mm | Average K | IOL implanted, D (A constant 119) | Actual postoperative refraction (spherical equivalent) | Predictive error of formula* | | | Visual acuity | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Age, years | Sex | | | | | Holladay | SRK/T | SRK II | Pre | Post | |
| 1 | 59 | M | 26.44 | 43.60 | 11.5 | +0.5 | -0.5 | 0 | +1.0 | CF 1 m | 20/100 | ERM |
| 2 | 40 | F | 27.6 | 44.25 | 8.0 | -1.12 | +0.29 | +0.98 | +2.8 | CF 50 m | 20/400 | |
| 3 | 48 | F | 28.8 | 43.00 | 6.0 | -0.75 | -0.25 | +0.25 | -1.5 | CF 1 m | 20/40 | |
| 4 | 61 | M | 29.10 | 44.00 | 4.0 | +1.0 | -0.50 | 0 | -1.5 | HM | CF 1 m | |
| 5 | 53 | M | 29.25 | 43.50 | 4.5 | -0.75 | +0.08 | +0.75 | +2.48 | CF 1 m | 20/400 | ERM |
| 6 | 52 | M | 29.90 | 38.50 | 9.5 | -0.50 | -0.90 | -0.40 | -1.90 | PL | CF 1 m | |
| Mean ± SD | | | 28.51 ± 1.27 | 42.80 ± 2.15 | 7.25 ± 2.94 | 0.77 ± 0.25 | 0.42 ± 0.28 | 0.40 ± 0.40 | 1.86 ± 0.67 | | | |

*Predictive error: + = overprediction; - = prediction
IOL = Intraocular lens; D = Diopters; CF = Counts fingers; ERM = Epiretinal membrane; HM = Hand motions

**TABLE II -** DATA OF PATIENTS WITH AVERAGE AXIAL LENGTH

| Number | Age, years | Sex | Axial length, mm | Average K | IOL implanted, D (A constant 119) | Actual postoperative refraction (spherical equivalent) | Predictive error of formula* Holladay | SRK/T | SRK II | Visual acuity Pre | Post | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 40 | M | 21.70 | 44.25 | 25.5 | -0.5 | +1.30 | +0.90 | +0.50 | HM | 20/200 | Residual emulsification |
| 2 | 48 | F | 22.05 | 48.00 | 20.5 | -0.25 | +0.25 | +0.65 | +0.25 | CF 1 m | 20/400 | |
| 3 | 52 | F | 22.65 | 43.25 | 23.0 | +0.62 | +0.58 | +0.58 | +0.18 | CF 1 m | 20/40 | |
| 4 | 65 | M | 22.80 | 45.00 | 22.0 | -1.5 | +1.50 | +1.50 | +1.90 | CF 2 m | 20/160 | |
| 5 | 54 | F | 23.30 | 42.75 | 21.0 | +1.0 | -0.60 | -0.60 | -0.60 | CF 50 m | 20/400 | |
| 6 | 57 | M | 23.59 | 44.50 | 19.0 | +0.75 | -0.27 | +0.13 | +0.13 | CF 1 m | 20/200 | |
| Mean ± SD | | | 22.68 ± 0.72 | 44.62 ± 1.85 | 22.3 ± 1.75 | 0.77 ± 0.44 | 0.75 ± 0.52 | 0.73 ± 0.45 | 0.59 ± 0.67 | | | |

*Predictive error: + = Overprediction; - = Prediction.
IOL = Intraocular lens; D = Diopters; HM = Hand motions; CF = Counts fingers

## DISCUSSION

Accurate calculation of IOL power in silicone-filled eyes is a challenge for many reasons. Measurement of axial length in the presence of silicone oil is fallacious (3). We often know in advance whether this oil will be removed or a long-term tamponade will be needed. Another problem is related to the change in axial length induced by application of an encircling buckle in many of these cases (4, 6). An additional factor that compromises the accuracy of using the original axial length is vitrectomy. When added to the procedure, it affects the postoperative position of the implanted IOL, leading to some myopic shift (7).

Different techniques have been recommended by other authors to solve the problems of biometry in silicone oil–filled eyes. Ghoraba et al measured the axial length after changing the sound speed in the vitreous cavity to 987 m/sec. The SRK/T formula was used for IOL calculation. Silicone oil was removed and cataract extraction was done with or without IOL implantation (8).

Another method included measuring the axial lens before the silicone injection (9).

Axial length measurements using conversion factor of 0.71 multiplied by the axial length measured in the presence of silicone oil has also been suggested. However, this was done for silicone oil of 1,300 centistokes only. IOL power can then be calculated using SRK/T formulae (10). This is limited by the possibility of macula-off retinal detachment and by using a scleral buckle, which alters the axial length (6, 10).

In this setting, we measured axial length after removal of silicone oil, in eyes that were already vitrectomized and had encircling buckle. No more changes are expected to occur to the globe size or contour that might affect the axial length measurement. This technique proved to be of good predictability and reasonable accuracy; it yielded an overall mean postoperative refractive error of only 0.77 diopter with no significant difference between elongated eyes and eyes with average normal axial length.

Another advantage of our procedure was that we accomplished all operative procedures in a single sitting (silicone oil removal, phacoemulsification, and IOL implantation). Thus the patients avoided second operative interventions.

Larkin et al used a factor of 0.64 multiplied by the measured vitreous cavity diameter with silicone oil in the eye to obtain the actual vitreous cavity diameter. This factor equals the sound speed of 987 m/sec in silicone oil-filled vitreous divided by 1,532 m/sec in normal vitreous. They then used the SRK/T formula. However, they reported the final visual acuity without details about the final refractive state of the patients (11).

Preoperative biometry using a sound speed of 987 m/sec in vitreous cavity filled with silicone oil and SRK/T formula gives predictable and accurate results in nonmyopic eyes with silicone oil of 1,000 or 5,000 centistokes. In highly myopic eyes, unsuitable formulas, posterior staphyloma, or presilicone proliferation can lead to high degrees of deviation from the predicted refraction (8).

Murray et al, who used the conversion factor of 0.71, correct for the apparent increase in axial length induced by silicone of viscosity 1,300 centistokes. The mean difference in actual and predicted refractive error is 0.74 diopters (standard deviation 0.75 diopters) for Group 1 (IOL placed in the capsular bag) and 1.31 diopters (standard deviation 1.4 diopters) for Group 2 (IOL placed in the ciliary sulcus) (10).

The final refraction depends not only on the axial length but also on the anterior chamber depth and the lens thickness. Both can be changed after silicone oil removal (12). This problem was avoided in our technique. Intraoperative biometry was adopted to overcome many of the above mentioned challenges while calculating the IOL power.

Concerning the choice of the calculation formula used in each particular case, we advise to avoid using the SRK II formula in eyes with long axial length, as it leads to significant overprediction. It is recommended to use either the SRK/T or Holladay formula in these eyes because they proved to be highly predictable in our cases. Our technique is suitable for eyes for which silicone oil removal, cataract extraction, and IOL implantation in one operation is indicated and may be applicable to eyes filled with silicone oil, because many of these eyes will eventually develop cataract, and in most cases silicone oil will subsequently have to be removed from them.

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