Fellow Eye Calculation

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Thomas Olsen

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Many surgeons have asked the question: "When I see this prediction error of the first eye, how can I use this information for the calculation of the second eye?" For a meaningful discussion, it is important to distinguish between a statistical error and a refractive surprise. As is the case with any refractive surprise, it is important to rule out any measurement gross errors (not just statistical), recording errors, IOL constant, IOL power label error, or other obvious mistakes. Gross errors can usually be identified by a repeat biometry of the pseudophakia eye to ensure the input variables were valid.

Having ruled out any mistakes or obvious input errors, we are left with a statistical error that has to do with the residual errors of the system as was described in the error propagation model. The idea of a fellow eye correction stems from the high symmetry that we often see between the right and left eye. In a way, the fellow eye surgery can be regarded as a repeat operation of the first eye. The symmetry is also apparent from the fact that the prediction error in the first eye correlates with that of the second eye. What does it mean? This means that no formula is perfect and that some factor related to the person is not picked up by the formula.

Case Study

To illustrate the fellow eye correlations and possible corrections, a study was performed on a series of 654 IOL implantations in 327 patients with two types of IOL: Alcon SA60AT or Abbott Tecnis ZCB00 implanted in both eyes using small incision phacoemulsification and in-the-bag placement of the IOL. The cases were collected some years ago while working at the University Clinic of Aarhus, Denmark. Preoperatively, the patients had Lenstar biometry of all intraocular distances which was necessary for the Olsen formula. The refractive outcome was recorded 1–3 weeks after surgery, and at that time, the biometry was repeated including measurement of the postop IOL position (pseudophakic, postoperative ACD).

The IOL power calculation was performed using the SRK/T as well as with the Olsen formula and the prediction error (defined as the observed mines the predicted refraction) calculated for the right and left eye in each case.

A significant correlation and regression coefficient was found between the prediction error of the right and left eye for both the SRK/T formula and the Olsen formula (Figs. 72.1 and 72.2, respectively). The regression coefficients were 0.52 and 0.38 for the SRK/T and the Olsen formula, respectively ($p < 0.001$).

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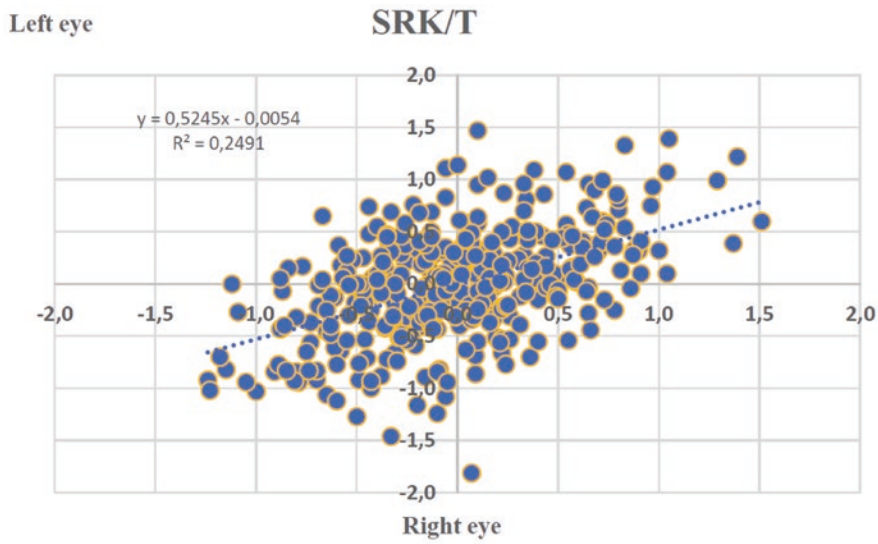

Fig. 72.1 Inter-eye correction of prediction error with the SRK/T formula in 345 cases

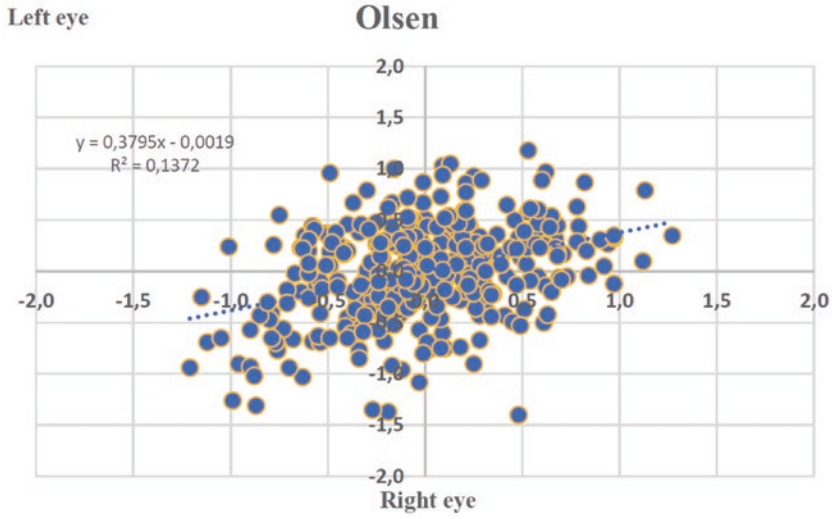

Fig. 72.2 Inter-eye correction of prediction error with the Olsen formula in 345 cases

Based on the observed inter-eye correlation, the prediction of one eye could be corrected according to a regression formula

$$Rx_{cor} = Rx_{exp} + \beta^{*} Px_{err} \qquad (72.1)$$

where Rx_{cor} and Rx_{exp} are the corrected and the uncorrected refractive prediction, respectively; Px_{err} is the observed error of the first eye; and β is the formula specific regression coefficient. The method based on the refractive prediction error has fully described a previous publication [1].

A highly significant correlation between the IOL position of the right and left eye was found (Fig. 72.3). The mean difference (±SD) between the postoperative ACD of the left and right eye was found to be 0.0 ± 0.13 mm. This corresponds to 94.5% of the cases within ±0.25 mm difference. With the Olsen formula, you have the

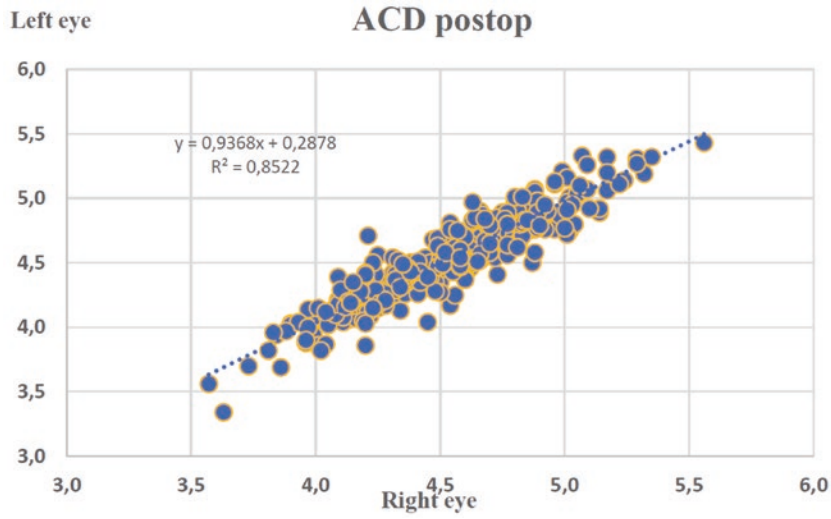

Fig. 72.3 Inter-eye correction of prediction error with the Olsen formula in 345 cases

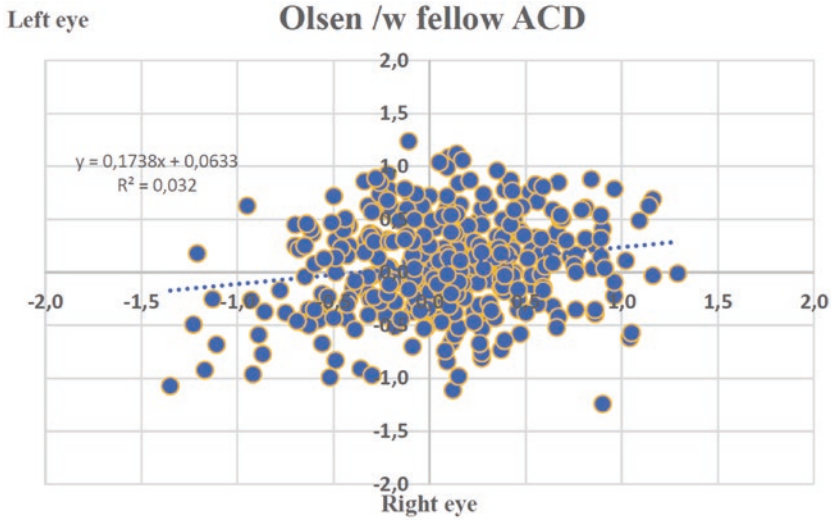

Fig. 72.4 Inter-eye correction of prediction error with the Olsen formula in 345 cases when the fellow postop ACD was used in the predictions

option to use the observed IOL position of the first eye and use this value as the predicted IOL position of the second eye. This was done as shown in Fig. 72.4. The regression coefficient R dropped from 0.38 to 0.17.

The improvement in prediction error (MAE) with fellow eye correction has been summarized in Fig. 72.5. The MAE dropped 14.2% with the SRK/T formula and 7.6% with the Olsen formula, respectively.

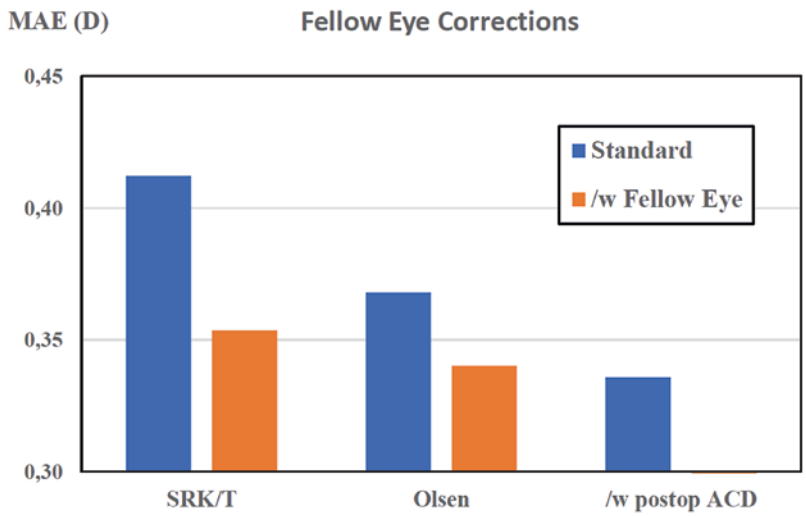

Fig. 72.5 Prediction error without and with fellow eye correction in 345 cases. For comparison is shown in the last column the prediction error when using the postoperative ACD in the 'predictions' with the Olsen formula

Comments

Several studies have now demonstrated a benefit of using the outcome of the first eye to improve the prediction of the second eye. Results vary according to the formula and the corresponding corrective term and hence also according to the improvement found after the fellow eye optimization.

Jabbour et al. [2] found no difference in adjusting for the full first-eye error in the second eye, whereas Covert et al. [3] found a statistically significant outcome by correcting 50% of the error from the first eye. The authors studied the Holladay and the SRK II formulas. This finding was largely supported by Aristodemou et al. [4] who likewise found a correction factor of 50% to be useful using the Hoffer Q, Holladay 1 and the SRK/T formulas.

Jivrajka et al. [5] demonstrated in a prospective study on 97 patients where the first eye prediction error exceeded 0.5 D (Haigis formula) that the refractive error of the second eye could be improved by modifying the IOL power to correct up to 50% of the error from the first eye. Turnbull and Barrett [6] found an improvement using a formula-specific correction factor ranging from 0.30 to 0.56 (Barrett Universal II 0.30; Hoffer Q 0.56; Holladay I 0.53; SRK/T 0.48) based on 169 patients.

In a previous study by Olsen[46], it was shown that the correction factor was depending on the formula (formulas studied: Olsen, SRK/T and SRK II) so that the correction factor used to adjust the prediction was higher for the formula with the lowest accuracy. As it was also demonstrated in the present case series, an alternative method of optimization is to use the fellow eye pseudophakic ACD as the predicted ACD in the Olsen formula with a similar improvement. This observation underlines the fact that a large part of the error must be due to inaccurate ELP estimation. The fellow eye ACD method has several advantages: It is simple and directly aimed at the main source of error, namely, the ELP prediction. It is independent from the refractive prediction error, which may be influenced by biometric errors, abnormal K-readings, large inter-eye difference in axial length, staphylomas, or other asymmetries unrelated to the anatomy of the capsular bag holding the IOL. It can be used specifically to optimize those cases where a large prediction error is suspected, i.e., short eyes, post-LASIK, post-keratoplasty cases etc.

The fact that the IOL power calculation can be optimized based on the outcome of the fellow eye

raises the question if this should be used in a wider scale. When we are comparing formula accuracy, we are often happy to see an improvement in MAE on the second decimal point. The fellow eye optimization has the potential to reduce the error considerably, depending on the formula (by 7–14% in the case study presented here). On the other hand, there is the question of cost. Waiting weeks to have the refraction of the first eye before doing the IOL power calculation and the surgery of the second eye adds substantial cost and time for the entire procedure. Moreover, many surgeons are now performing bilateral simultaneous cataract surgery to speed up recovery and reduce cost.

There is no question the future will demand accurate IOL power calculation in the first place.

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