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Predictability of Intraocular Lens Power Calculation After Simultaneous Pterygium Excision and Cataract Surgery

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Abstract: This study was aimed to assess the predictability of intraocular lens (IOL) power calculation after simultaneous pterygium excision and phacoemulsification with IOL implantation. We retrospectively reviewed the clinical charts of 60 eyes of 60 consecutive patients (mean age ± standard deviation, 73.5 ± 7.0 years) who developed pterygium and cataract. We determined visual acuity (logMAR), manifest spherical equivalent, manifest astigmatism, corneal astigmatism, and mean keratometry, preoperatively and 3 months postoperatively. Corrected visual acuity was significantly improved from 0.19 ± 0.20 preoperatively to −0.06 ± 0.07 postoperatively ($P < 0.001$, Wilcoxon signed-rank test). Uncorrected visual acuity was also significantly improved from 0.62 ± 0.33 preoperatively to 0.31 ± 0.32 postoperatively ($P < 0.001$). At 3 months, 48% and 82% of the eyes were within ± 0.5 and ± 1.0 D, respectively, of the targeted correction. We found significant correlations of the prediction errors with the changes in the mean keratometry (Spearman signed-rank test, $r = -0.535$, $P < 0.001$) and with the pterygium size ($r = -0.378$, $P = 0.033$). Simultaneous pterygium and cataract surgery was safe and effective, and the accuracy was moderately predictable. However, it should be noted that a significant myopic shift occurred postoperatively, possibly resulting from the steepening of the cornea after pterygium removal, especially when the size of pterygium was large.

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Abbreviations: CDVA = corrected distance visual acuity, D = diopter, HOAs = higher order aberrations, IOL = intraocular lens, logMAR = logarithm of the minimal angle of resolution, SD = standard deviation, UDVA = uncorrected distance visual acuity.

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INTRODUCTION

Pterygium commonly occurs in older patients, who are often accompanied with senile cataract formation.[1,2] The treatment of pterygium is its removal which can be performed prior to or combined with cataract surgery. Pterygium excision followed by phacoemulsification with intraocular lens (IOL) implantation as 2-step procedures may have advantages over simultaneous pterygium and cataract surgical procedures in terms of better corneal stability and subsequent higher predictability of IOL power calculation, as pterygium and cataract surgery possibly induces a change in the corneal refractive power. However, most older patients tend to prefer single-step combined procedures rather than 2-step separate procedures, as this simultaneous surgery provides faster visual recovery and cosmetic improvement, and contributes to the reduction of hospital visits and subsequent overall cost for the treatment.[3,4] Moreover, accurate IOL power calculation is essential for better visual and refractive outcomes, and subsequent patient satisfaction, even when simultaneous pterygium and cataract surgery is performed. However, to our knowledge, there have so far been no published studies on the detailed visual and refractive outcomes of simultaneous pterygium excision and cataract surgery. In addition, the predictability of IOL power calculation after simultaneous pterygium excision and cataract surgery has not so far been investigated. The aim of this study is to retrospectively assess the clinical outcomes of simultaneous pterygium excision and cataract surgery with special attention to the refractive accuracy of IOL power calculation in such patients.

PATIENTS AND METHODS

Study Population

We retrospectively reviewed the clinical charts of 60 eyes of 60 consecutive patients who had undergone simultaneous primary pterygium excision and standard phacoemulsification with IOL implantation at Kitasato University Hospital, and who completed a 3-month follow-up. This sample size offered 86% statistical power at the 5% level to detect a 0.20-difference in logarithm of the minimal angle of resolution (logMAR) of visual acuity, when the standard deviation (SD) of the mean difference was 0.50. The exclusion criteria was as follows: extreme pterygium (because of unreliable data), postoperative corrected distance visual acuity (CDVA) of >0.15 logMAR (because of unreliable refraction), any history of ocular surgery, ocular trauma, or other concomitant eye diseases. Patient data was anonymized before access and/or analysis. Written informed consent was obtained from all patients for the surgery after explanation of the nature and possible consequences of the study. This retrospective review of the data was approved by the Institutional Review Board at Kitasato University and followed the tenets of the Declaration of Helsinki. Our Institutional

Review Board waived the requirement for informed consent for this retrospective study.

Surgical Procedures of Pterygium and Cataract Surgery

For primary pterygium surgery, after subconjunctival injection of lidocaine-epinephrine (1:100,000) into the tissue, the pterygium head was bluntly lifted off from the cornea, and the pterygium head and body were excised at ~4 mm from the limbus. Abnormal subconjunctival fibrous tissue was trimmed away, and abnormal scarring on the cornea was polished. A conjunctival autograft was moved from the superior bulbar conjunctiva in order to cover the defect area with 8–0 absorbable polyglycolic sutures without the use of mitomycyin C.

For cataract surgery, standard phacoemulsification was performed. The surgical technique consisted of a capsulorhexis, nucleus and cortex extraction, and a monofocal IOL (AQ-110NV, Staar Surgical, CA) implantation through a temporal 2.8-mm clear corneal incision. All surgeries were uneventfully performed by 1 experienced surgeon (K.K.) using the same technique. In 43 of 60 eyes, we selected emmetropia as the target refraction. In the remaining 17 eyes, we intentionally selected a slight myopia for near vision. Postoperatively, steroidal (0.1% betamethasone, Rinderon™, Shionogi, Osaka, Japan), antibiotic (0.3% levofloxacin, Cravit™, Santen, Osaka, Japan), diclofenac sodium (0.1% Diclod™, Wakamoto, Tokyo, Japan) medications were topically administered 4 times daily for 1 month, the dose being reduced gradually thereafter.

Assessment of Prediction Error and Absolute Error

IOL power calculations were performed by the SRK/T formula using the axial length measured by partial coherence interferometer (IOL Master™, Carl Zeiss Meditec, Jena, Germany) and the keratometric readings measured by an autokeratometer (ARK-730A™, Nidek Co Ltd, Gamagori, Japan), without any correction. Each measurement was repeated at least 5 times and the mean value was used for the analysis. The prediction errors were calculated by subtracting the predicted postoperative refraction from the postoperative spherical equivalent 3 months postoperatively, these absolute values, and the percentages of the prediction errors within ± 0.5 diopter (D) and ± 1.0 D were calculated.

Subgroup Analysis

In order to investigate the relationship of the prediction errors with the pterygium length, we additionally determined the horizontal length of pterygium preoperatively in 30 eyes of the study population with the data of the corneal diameter by a manual caliper and the slit-lamp photograph. The pterygium length determined as being the horizontal distance between the pterygium head and the vertical tangent to the corneal limbus, was calculated from the ratio of this distance with the corneal diameter, on the preoperative slit-lamp photograph, as described previously.[5]

Statistical Analysis

All statistical analyses were performed using a commercially available statistical software (Ekuseru-Toukei 2010, Social Survey Research Information Co, Ltd, Tokyo, Japan). The normality of all data samples was first checked by the Kolmogorov–Smirnov test. As the data did not fulfill the criteria for normal distribution, the Wilcoxon signed-rank test was used to compare the pre- and postsurgical data, and the relationship between 2 sets of data was analyzed by Spearman's rank correlation test. The results are expressed as mean ± SD, and a value of $P < 0.05$ was considered statistically significant.

RESULTS

Patient Demographics

Preoperative and postoperative patient demographics are listed in Table 1. The patient age at the time of surgery was 73.5 ± 7.0 years (range 57–86 years). All surgeries were uneventful and no intraoperative complication was observed in this series.

Visual and Refractive Outcomes

LogMAR UDVA was significantly improved from 0.62 ± 0.33 preoperatively to 0.31 ± 0.32 postoperatively ($P < 0.001$, Wilcoxon signed-rank test). LogMAR CDVA was also significantly improved from 0.19 ± 0.20 preoperatively to −0.02 ± 0.11 postoperatively ($P < 0.001$). The manifest spherical equivalent was significantly changed from 0.22 ± 2.55 D preoperatively to −0.84 ± 0.93 D postoperatively ($P < 0.001$).

TABLE 1. Preoperative Demographics of the Study Population in Eyes Undergoing Simultaneous Pterygium and Cataract Surgery

Preoperative Demographics (Mean ± Standard Deviation)	
Number of eyes	60
Male:female	37: 23
Age	73.5 ± 7.0 years (range, 57 to 86 years)
LogMAR UDVA	0.62 ± 0.33 (range, 0.05 to 1.70)
LogMAR CDVA	0.19 ± 0.20 (range, −0.08 to 1.00)
Manifest astigmatism	−1.43 ± 1.21 (range, −4.50 to 0.00)
Corneal astigmatism	2.65 ± 2.28 D (range, 0.18 to 10.25 D)
Mean keratometric readings	43.6 ± 1.8 D (range, 39.2 to 48.5 D)
Axial length	23.45 ± 1.07 mm (range, 21.54 to 27.77 mm)

CDVA = corrected distance visual acuity, D = diopter, logMAR = logarithm of the minimal angle of resolution, UDVA = uncorrected distance visual acuity.

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Astigmatic Outcomes

The corneal astigmatism was significantly decreased from 2.65 ± 2.28 D preoperatively to 1.44 ± 1.89 D postoperatively ($P < 0.001$). The manifest astigmatism was also significantly decreased from -1.43 ± 1.21 D preoperatively to -1.00 ± 0.99 D postoperatively ($P = 0.001$).

Corneal Keratometry

The mean keratometric reading was significantly increased from 43.6 ± 1.8 D preoperatively to 44.2 ± 1.7 D postoperatively ($P < 0.001$). We found a significant correlation between the prediction errors and the changes in the mean keratometry (Spearman correlation coefficient, $r = -0.535$, $P < 0.001$) (Figure 1).

Effectiveness Outcomes

LogMAR UDVA was significantly improved from 0.56 ± 0.28 preoperatively to 0.26 ± 0.30 postoperatively ($P < 0.001$). Twenty-seven (63%) and 13 (30%) of 43 eyes had UDVA of 10/20 and 20/20 or better 3 months postoperatively, respectively, when undercorrected 17 eyes (28 %) for near vision were excluded.

Predictability

A scatter plot of the attempted versus the achieved refraction (manifest spherical equivalent) 3 months postoperatively is shown in Figure 2. The achieved refraction of -0.84 ± 0.93 D was significantly more myopic than the targeted refraction of -0.52 ± 0.76 D ($P = 0.001$). The IOL power prediction errors and the absolute errors are -0.32 ± 0.74 D and 0.62 ± 0.51 D, respectively. Twenty-eight (48%) and 49 (82%) of 60 eyes were within ± 0.5 D and 1.0 D, respectively, of the targeted correction.

Secondary Surgeries/Adverse Events

Only 1 eye (2%) developed a slight recurrence of pterygium, but was followed without additional surgical intervention. Two eyes (3%) developed posterior capsular opacification, requiring an Nd-YAG capsulotomy. Neither cataract incision-related complication, keratectasia, nor other vision-threatening complications was seen at any time during the 3-month observation period.

Subgroup Analysis

In the subgroup analysis, we found a modest, but significant correlation between the pterygium size and the prediction errors (Spearman correlation coefficient, $r = -0.425$, $P = 0.019$) (Figure 3).

DISCUSSION

In the present study, our results demonstrated that simultaneous pterygium removal and phacoemulsification with a monofocal IOL was safe and effective, and provided moderately predictable results in eyes with pterygium and cataract. We should be aware that a significant myopic shift occurred after surgery, possibly resulting from the steepening of the cornea, especially when the size of pterygium was large. As far as we can ascertain, this is the first study to assess the predictability of IOL power calculation in patients with pterygium and cataract. We believe that this information will be helpful for more accurate IOL power calculation for patients undergoing simultaneous pterygium and cataract surgery in a clinical setting.

With regard to the clinical outcomes of these combined procedures, there have been only a few published studies on simultaneous pterygium and cataract surgery.[3,4] Ibechukwu[3] first described that simultaneous surgical procedures were

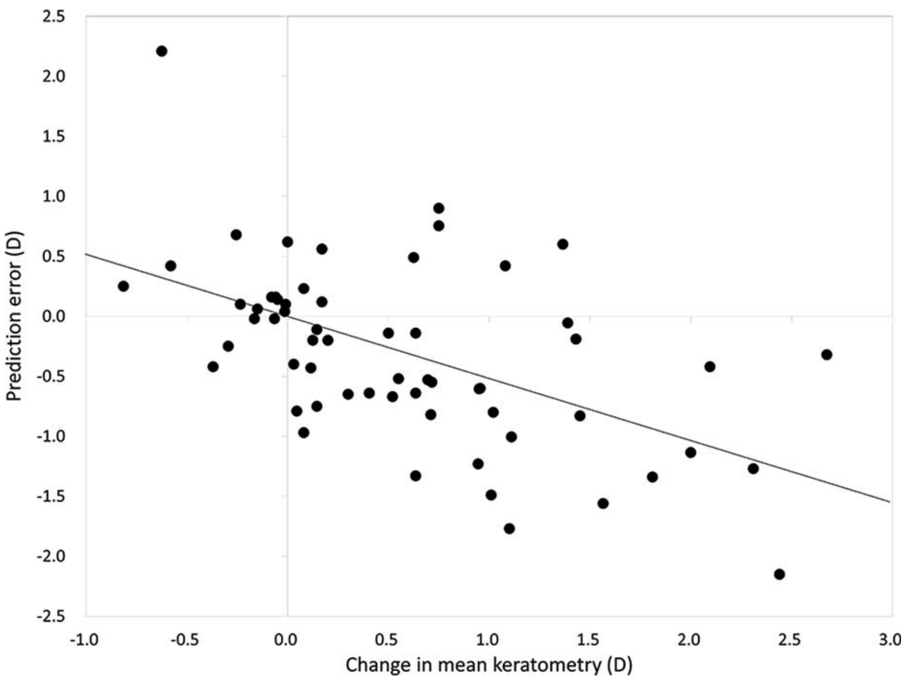

FIGURE 1. A graph showing a significant correlation between the prediction errors and the changes in the mean keratometry (Spearman correlation coefficient, $r = -0.535$, $P < 0.001$).

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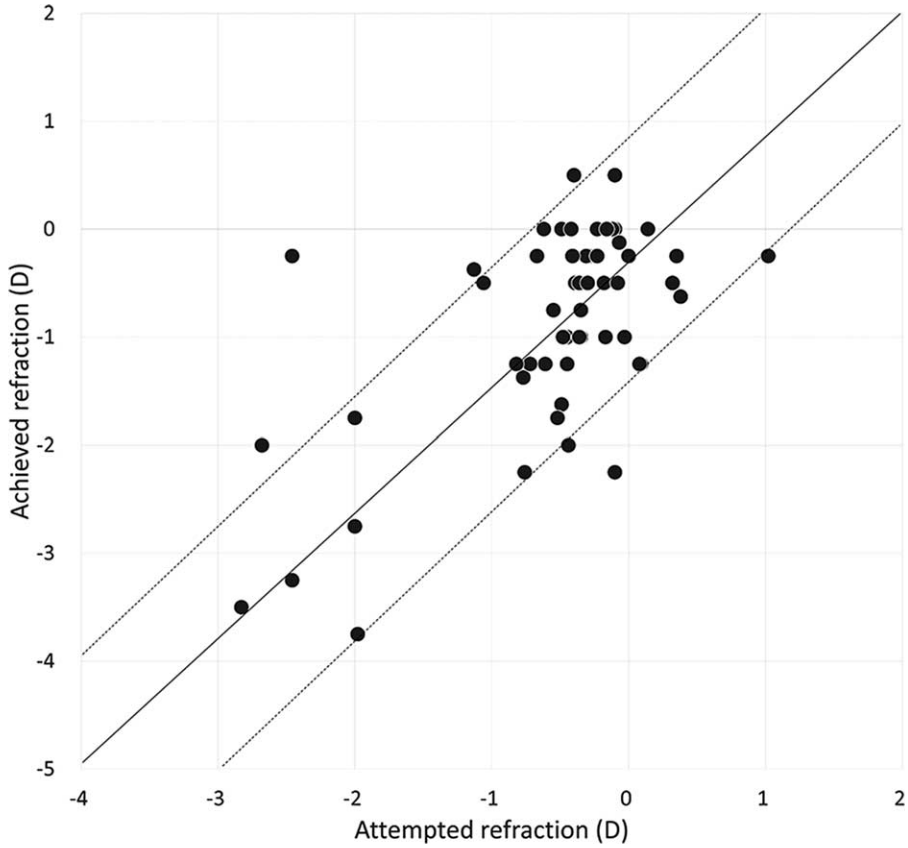

FIGURE 2. A scatter plot of the attempted versus the achieved refraction (manifest spherical equivalent) 3 months postoperatively in eyes undergoing simultaneous pterygium excision and cataract surgery. Twenty-eight (48%) and 49 (82%) of 60 eyes were within $\pm$0.5 D and 1.0 D, respectively, of the targeted correction.

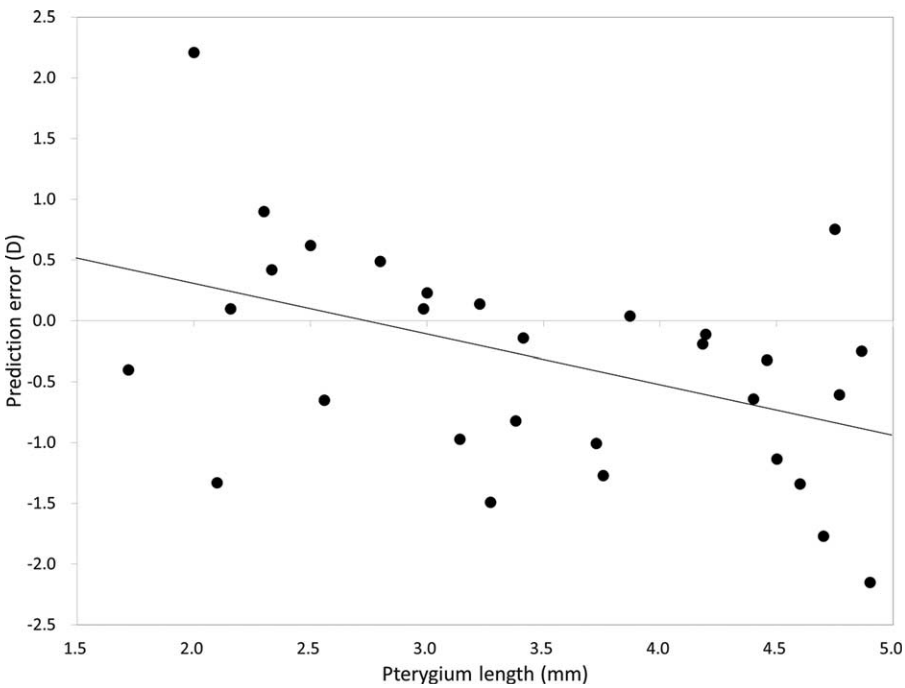

FIGURE 3. A graph showing a significant correlation between the pterygium length and prediction errors (Spearman correlation coefficient, $r = -0.425$, $P = 0.019$).

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beneficial for cost reduction and visual prognosis, but neither visual nor refractive outcomes of these procedures were mentioned in that study. Gulani et al[4] stated that 63% of patients had visual recovery to 6/12, and that the mean with-the-rule and against-the-rule astigmatism 6 months postoperatively was 1.3 D and 1.2 D, respectively. In the present study, we have demonstrated that the percentage of eyes within $\pm$ 0.5 and $\pm$ 1.0 1.0 D of the targeted correction were 48% and 82%, respectively, suggesting that the combined procedures offer moderate predictability of the intended correction. To the best of our knowledge, this is also the first study to assess the detailed visual and refractive outcomes of simultaneous pterygium excision and cataract surgery.

Our results showed that there was a significant increase in the mean keratometry and that this increase in keratometry was significantly associated with the postoperative prediction errors. Our former findings was in line with previous studies on the changes in the corneal power after pterygium excision.[5–13] Our latter findings indicate that the postoperative myopic shift was largely attributed to the steepening of the cornea as a result of pterygium removal, as the presence of pterygium tends to flatten the cornea. Yasar et al also demonstrated that the pooling of tears at the pterygium apex plays an important role, but fibrovascular traction has no effect on the corneal topographical changes induced by pterygium.[9] Moreover, our subgroup analysis revealed a modest, but significant correlation between the pterygium size and the prediction errors, suggesting that a larger myopic shift occurred after these combined procedures when the size of pterygium is larger. Tomidokoro et al reported that removal of pterygium having 20% extension on the cornea will lead to a 0.91 D increase of the corneal spherical power, but that this prediction may contain considerable inaccuracy.[7] Kim et al found a significant correlation between the length of pterygium and the change in the mean keratometry after pterygium removal, although pterygium $<$2.0 mm in length rarely induced the postoperative change of the cornea.[5] Nejima also stated, in a study of 562 eyes, that topographic changes after pterygium excision were associated with pterygium size.[13] We should be aware that a myopic shift occurred after simultaneous pterygium excision and cataract surgery, especially when the size of pterygium is large.

There are several limitations to this study. First, it was conducted in a retrospective fashion. A randomized, controlled study may provide further information for confirming the authenticity of these results. Second, we did not assess corneal higher order aberrations (HOAs) in the present study. Corneal HOAs have been reported to be significantly decreased after pterygium surgery.[14–17] We cannot deny the possibility that corneal HOAs play a role in the predictability of IOL power calculation in eyes with pterygium and cataract. Third, we had no postoperative data of sequential pteriygum and cataract surgery. Considering that the results of pterygium and cataract surgery are surgeon-skill dependent, it would be clinically useful to compare the post-surgical data of the 2 groups (simultaneous and sequential surgery). Fourth, the follow-up period was set at 3 postoperative months. However, it has been demonstrated that refractive components of the cornea are markedly modified by pterygium excision, but stabilize 1 month after surgery.[7] We assume it unlikely that the results were substantially changed in the late postoperative period, as the corneal shape was considered to have stabilized, taking into account the wound-healing responses of the cornea. A further long-term observation is still necessary to clarify this point. Fifth, the sample size was relatively small in the present study, although it offered $\geq$80% statistical power at the 5% level.

In conclusion, our results support the view that simultaneous pterygium excision and phacoemulsification with IOL implantation was safe and effective and that the accuracy was moderately predictable for the treatment of pterygium and cataract. The results indicate that simultaneous pterygium and cataract surgery is a feasible option for older patients developing pterygium and cataract. However, it should be noted that a significant myopic shift occurred after surgery, possibly resulting from the steepening of the cornea after pterygium removal, especially when the size of pterygium was large.

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