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Effect of Pterygium on the Calculation of Intraocular Lens Power

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Abstract: **Purpose:** To evaluate the effect of pterygium on the intraocular lens (IOL) power by bioassay, and reduce the error of the degree of intraocular lens before cataract combined with pterygium resection. **Methods:** A total of 68 eyes of 34 subjects who were scheduled for unilateral primary pterygium excision and limbal stem cell autograft transplantation were included in this study. Anterior segment photographed images were taken of eyes with pterygia to calculate the pterygium length and area using the ImageJ program. Preoperative and 3-month postoperative the best corrected distance visual acuity (BCDVA), corneal astigmatism, corneal curvature radius, corneal curvature, axial length, anterior chamber depth, and intraocular lens degree (SK-T、SK-Ⅱ) were obtained for eyes with pterygium and their healthy fellow eyes (control group). **Results:** 34 pterygium patients were included, with a mean age of 55.9 years and a standard deviation of 6.9. The average pterygium measured 3.21 ±0.92 mm in length, 5.69 ±1.15 mm in breadth, and 9.55 ±4.20 mm2 in area. IOL power and related factors are positively correlated with the size of pterygium. If the pterygium size is larger than 2.40mm, 5.60mm or 7.38mm2 and simultaneous surgery is planned, the implanted IOL power should be at least 0.50 D smaller than the calculated power. **Conclusions:** According to the size of pterygium, corneal astigmatism before surgery, the difference of corneal astigmatism in both eyes before surgery, the difference of IOL power in both eyes before surgery and the difference of IOL power before and after surgery, cataract surgeons can prepare an optimal surgical strategy for pterygium combined with cataract patients.

1. Introduction

Pterygium is common ocular surface diseases. It is a wedge-shaped fibrovascular tissue that rises above the cornea's surface in a superficial growth. Pterygium's pathogenesis is still being researched. A more successful treatment at the moment is pterygium excision combined with autologous limbal stem cells or amniotic membrane transplantation [1]. Pterygium is more common in middle-aged and elderly people, so most of them are complicated with cataract. Pterygium of a certain size can

cause considerable changes in corneal properties. According to studies, the form of pterygium has little effect on corneal characteristics, however the horizontal length, width, depth, and approximate total area of pterygium on the corneal surface are all related to corneal parameters, which in turn affects the accuracy of intraocular lens power measurement[2,3]. The optimal treatment technique for patients with pterygium and cataract is to remove the pterygium first, followed by cataract surgery once the corneal morphology is stabilized. It is possible to achieve excellent predictability in the calculation of IOL Power in this manner. However, individuals in their forties and fifties are more likely to seek combination pterygium and cataract surgery to speed up vision recovery, reduce hospitalizations, and reduce costs [4]. Since IOL power measurement before cataract combined with pterygium resection carries a risk of error, our goal was to assess the impact of pterygium on this measurement and its related factors (corneal curvature, axial length, anterior chamber depth, etc.). This would also improve patient visual quality after surgery and lessen the need for secondary surgery.

2. Patients and Methods

The study in line with the tenets of the Helsinki Declaration Obtain the agreement of each patient and the blessing of the medical school's humanistic ethics committee at the Hospital of Wannan Medical College. This prospective research comprised 34 individuals with monocular pterygium, comprising 17 male eyes and 17 female eyes. In the selected patients, the pterygium measured 4.5mm in length and the axial length measured 22.00-24.50mm. Patients with recurring or double-headed pterygium, past trauma or surgery, and other corneal disorders such as keratitis and keratoconus, as well as other conditions causing structural changes in the eye, were excluded from the research.

Before and three months after surgery, all patients had a thorough ophthalmic examination that included basic patient information (Age, sex, and different eyes), slit lamp biomicroscopy (Japan Topcon Slit lamp) and fundus observation (66 YZ11D direct ophthalmoscope), best corrected visual acuity (BCVA) and corneal curvature (Japan NIDEK automatic computer optometry/curvature instrument ARK-710A) , axial length, anterior chamber depth, intraocular lens power (SK-T、SK-Ⅱ; CINESCAN A/B Ultrasonic ophthalmic diagnostic instrument), and pterygium size as measured by anterior segment image analysis (Heidelberg Spectralis HRA-OCT). The horizontal distance from the top of the pterygium to the nasal corneopcleral margin was taken as the length, and the vertical distance between the upper and lower ends of the pterygium invading the corneal limbus was taken as the width, and the area was calculated as the measured length and width (length width /2)5.

Pterygium excision and autologous limbal stem cell transplantation were performed by senior and experienced ophthalmologists in our department. Useful area after the ball subconjunctival infiltration anesthesia, cut open useful in limbal conjunctiva, blunt separate sclera and useful under the neck and fascia, from 2 mm cut useful at the neck of limbus of cornea, toothed tweezers directly avulsion of pterygium corneal part, remove residual useful organization, cut off Nu body fascia tissue, all patients don't need to control bleeding by burning. According to the size of the exposed site, the nasal exposed site was covered with the free limbal conjunctival autologous graft separated from the bulbar conjunctival membrane of the superior temporal region. The limbal conjunctival autologous graft was overlapped, and then the surgical eye was fixed with 10-0 silk suture. Levofloxacin eye drops and recombinant human epidermal growth factor eye drops were used for external use after operation, and flumilone eye drops were added 1 week after operation, decreasing from 4 times a day for 2 weeks. Two weeks after surgery, the corneal bandage lens was removed, all sutures were removed, and sodium hyaluronate eye drops were given for external use. All the selected patients were regularly reviewed after operation and recovered well without any related

complications.

In order to evaluate the influence of pterygium size on the measurement of corneal and IOL strength, the data of pterygium eyes and contralateral normal eyes before and 3 months after operation were compared and analyzed, and the relationship between the length, width and area of pterygium and the measurement difference of IOL and the influencing factors were evaluated. Using SPSS software (Windows, SPSS, Inc. Version 20.0) for statistical analysis. All data with normal distribution were reported as mean standard deviation ($\bar{X} \pm S$), while data without normal distribution were reported as median (interquartile range). The Shapiro-Wilk test was utilized to determine whether the data distribution was normal. Before and after pterygium surgery, the corneal and intraocular lens strength measurements were compared using the Wilcoxon test. The relationship between the measurement of the IOL degree and its associated parameters and the length and width of the pterygium was examined using the Pearson correlation analysis or Spearman correlation analysis. The crucial point significance threshold of pterygium length, width, and area associated components change was established using receiver characteristic operating curve (ROC) analysis, and IOL degree difference of 0.5 diopter (D) and above was set as P value less than 0.05.

3. Results

This study included 34 pterygium patients in all, 25 of whom had the condition in their right eye and 9 in their left. There were a total of 34 pterygium eyes (study group) and 34 healthy contralateral eyes (control group). The 17 women and 17 males had a combined mean age of 55.9 ± 6.9 years (range 42 to 71 years). Pterygium dimensions were 3.21 ± 0.92 mm on average (range 1.34 to 4.50 mm), 5.69 ± 1.15 mm on average (range 3.65 to 8.56 mm), and 9.55 ± 4.20 mm2 on average (range 2.46 to 19.22mm2). The best corrected distance visual acuity, corneal astigmatism, corneal curvature radius, corneal curvature, axial length, anterior chamber depth, and intraocular lens degree and other parameters before and after surgery in the study group and the control group are shown in Table 1.

The length, width, and area of pterygium had no statistical link with the preoperative binocular vertical corneal curvature difference, however there was a significant correlation between the length, width, and area of pterygium and the preoperative binocular horizontal corneal curvature difference (Table 2). The ROC curve of length, width and area of pterygium was made based on the criterion of whether it affected the horizontal curvature of cornea (Fig.1/table 3). The ACU of the length corresponding to the curve is 0.877, $P<0.01$; The ACU of the width corresponding to the curve is 0.813, $P<0.01$; The ACU of the corresponding area under the curve is 0.851, $P<0.01$, indicating statistical significance, corresponding diagnostic critical points were 2.51mm, 5.50mm and 6.77mm2, respectively.

The findings of comparing the association between the length, width, and area of the pterygium and the variation in the degree of intraocular lens before and after surgery revealed that the link between the three variables was low (Table 4). There was no statistical significance in the ROC curve of length, width and area of pterygium using the difference value of intraocular lens (SK-T) for 0.5D before and after surgery. Under SK-Ⅱ formula, preoperative and postoperative intraocular lens difference values of 0.5D were selected to make corresponding ROC curves of length, width and area of pterygium (Fig2). The ACU under the curve corresponding to the length is 0.725, $P< 0.05$; The ACU under the curve corresponding to the width is 0.746, $P<0.05$; The area under the corresponding curve ACU is 0.754, $P<0.05$, indicating statistical significance, corresponding diagnostic critical values were 2.78mm, 5.60mm and 7.38mm2, respectively (table 5). The length of 2.78mm, width of 5.60mm and area of 7.38mm2 were critical points to evaluate the effect of

pterygium size on the difference of IOL before and after surgery for at least 0.5D.

Table.6 show there was no substantial difference in IOL degree difference determined by the SK-T and SK-II formulas between the study and control groups before and 3 months after surgery ($P > 0.05$).

Table 1: Biometric data collected before surgery, three months after surgery, and in the control. group.

	Study Group		Control Group	P	P1	P2
	Preoperative	3 Mo Postop				
BCVA	0.6 (0.4)	0.8 (0.25)	0.8 (0.4)	<0.001	<0.001	0.869
vCRC (mm)	7.67 ±0.30	7.60 ±0.25	7.64 ±0.25	0.070	0.719	0.547
vCC (D)	44.11 ±1.75	44.41 ±1.50	44.21 ±1.40	0.115	0.601	0.561
hCRC (mm)	8.06 ±0.44	7.64 ±0.25	7.64 ±0.25	<0.001	<0.001	0.958
hCC (D)	41.94 ±2.24	44.22 ±1.47	44.23 ±1.49	<0.001	<0.001	1.000
CA (D)	-1.75(2.63)	-0.75(0.75)	-0.50(0.50)	<0.001	<0.001	0.031
ACD (mm)	2.91 (0.4)	2.95 (0.35)	2.99 (0.28)	0.299	0.299	0.854
AL (mm)	22.83 ±0.76	22.85 ±0.82	22.80 ±0.82	0.599	0.876	0.786
SK-T (D)	22.68 ±1.90	21.26 ±2.02	21.50 ±1.84	<0.001	0.011	0.568
SK-II (D)	22.47 ±1.82	21.16 ±1.99	21.40 ±1.78	<0.001	0.016	0.606

BCVA= best corrected visual acuity; vCRC= vertical corneal radius of curvature; vCC= vertical corneal curvature; hCRC=horizontal corneal radius of curvature; hCC= horizontal corneal curvature; CA = corneal astigmatism; ACD = anterior chamber depth; AL = axial length.

P: Comparison of preoperative and postoperative values; P1: Comparison of preoperative values and control group; P2: Comparison of postoperative values and control group, as shown in Figure 1-2.

Table 2: Correlation analysis of pterygium size and corneal curvature

	vCCD	P1	hCCD	P2
Length (mm)	r=0.015	0.933	r=0.505	0.002
Width (mm)	r=0.090	0.615	r=0.591	P<0.001
Area (mm2)	r=0.032	0.857	r=0.553	0.001

vCCD = vertical corneal curvature difference; hCCD = horizontal corneal curvature difference.

Table 3: ROC curve: the effect of pterygium size on corneal curvature.

	Diagnostic cut-off value	AUC	p	Youden's index	sensitivity	specificity
Length (mm)	2.51	0.877	0.001	0.837	92.6%	87.5%
Width (mm)	5.50	0.813	0.008	0.567	69.2%	87.5%
Area (mm2)	6.77	0.851	0.003	0.721	84.6%	87.5%

Table 4: Correlation analysis of pterygium size and IOL degree difference before and after surgery

	SK-T	P1	SK- II	P2
Length (mm)	r=0.387	0.024	r=0.372	0.030
Width (mm)	r=0.468	0.005	r=0.455	0.007
Area (mm2)	r=0.451	0.007	r=0.448	0.008

Table 5: ROC curve: the effect of pterygium size on the difference of intraocular lens measurement.

	Diagnostic cut-off value	AUC	p	Youden's index	sensitivity	specificity
Length (mm)	2.78	0.725	0.032	0.568	81.8%	75.0%
Width (mm)	5.60	0.746	0.019	0.432	68.2%	75.0%
Area (mm2)	7.38	0.754	0.016	0.568	81.8%	75.0%

Table 6: Comparison of IOL differences in the study and control groups before and after surgery

	Study Group	Control Group	P
SK-T (D)	1.41±1.20	-0.03±0.24	<0.001
SK-II(D)	1.31±1.06	0.00±0.21	<0.001
P	0.109	0.106	-

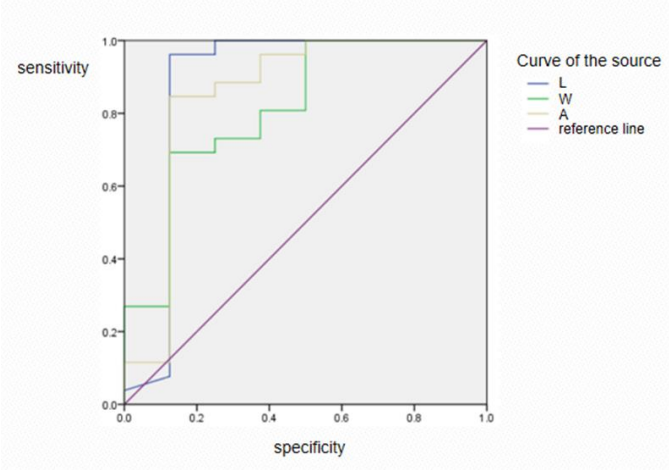

Figure 1: ROC curve.

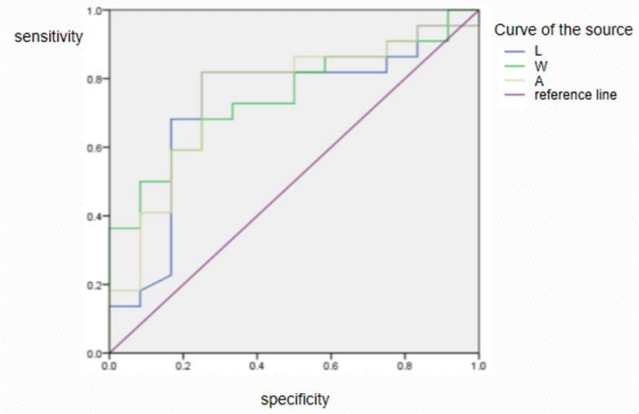

Figure 2: ROC curve.

4. Discussion

In patients with pterygium compounded by cataract, there are problems with the determination of the preoperative IOL degree because pterygium may alter the assessment of corneal parameters6. These changes are significantly improved at least one month after surgery, and gradually stable and normal at three months after surgery [7,8]. The best course of action for patients with pterygium

complicated by cataract is pterygium removal first, followed by cataract surgery once the corneal morphology is stabilized. However, in order to hasten vision recovery, lower the number of hospital stays, and lower expenditures, middle-aged and older patients are more likely to need combination pterygium and cataract surgery4.

IOL measurement was connected to anterior chamber depth, axial length, and corneal curvature. It is believed that asymptomatic little pterygium has no impact on biometric tests. The biological measurements and, thus, the accuracy of the IOL measurement may be impacted by a bigger pterygium. Asymptomatic small pterygium is not thought to affect biometric assays. However, a larger pterygium may affect the biological measurements and thus the accuracy of the IOL measurement [6,9]. Axial length and anterior chamber depth did not alter significantly ($P>0.05$) between preoperative and postoperative 3 months in this investigation, indicating that pterygium had no discernible impact on these variables. According to Oltulu et al10 findings, pterygium mostly affects the anterior surface of the cornea, but has no discernible impact on the posterior surface of the cornea. According to reports, pterygium surgery can improve corneal curvature11 and there is a significant difference in the horizontal curvature of the cornea between the two eyes before and after surgery, while there is no significant change in the vertical curvature of the cornea, which is consistent with current studies. According to the influence of the size of pterygium on the corneal curvature, there is no clear conclusion on the critical point of the operation time. Domestic and foreign studies have reported that the length of pterygium invasion and cornea 2.5-3.0 mm has a significant effect on the corneal curvature, and it is necessary to perform surgical treatment of pterygium [3,12]. The horizontal curvature of the cornea was found to be positively and significantly correlated with the length, width, and area of the pterygium in this study. The preoperative difference in corneal curvature between the two eyes allowed researchers to determine whether the pterygium affected the cornea's curvature. Through the analysis of the difference of corneal horizontal curvature before and after surgery, the size of pterygium can be used to determine whether pterygium affects the horizontal curvature of cornea. Length of 2.51mm, width of 5.50mm and area of 6.77mm2 are the diagnostic critical points to evaluate the effect of pterygium on the horizontal curvature of cornea.

Kamiya et al. 4evaluated the amount of deviation of the target IOL degree calculated using the SRK-T formula after cataract and pterygium simultaneous surgery. The study found that 52% of patients had IOL degree deviation greater than 0.50D, but the authors did not specify the size of pterygium in the study[10,11]. The primary goal of this study was to investigate the effect of pterygium size on IOL power computation. In daily clinical practice, a lens degree mistake of 0.5D has a significant impact on the ultimate decision of IOL degree. We concluded that pterygium with a length greater than 2.78mm, a width greater than 5.60mm, and an area greater than 7.38 mm2 resulted in a change in IOL degree value of more than 0.5D, and that there was a positive association between IOL degree error and pterygium length, width, and area. It has been found previously that pterygium affects the measurement of IOL degree by affecting the horizontal curvature of the cornea, and combined with the diagnostic boundary points (length 2.51mm, width 5.50mm and area 6.77mm2) affecting the horizontal curvature of the diagonal membrane of pterygium, we believe that if the length, width and area of pterygium are lower than these levels, And does not cause symptoms, only cataract surgery is recommended, and has little impact on refractive error. If the length and area of the pterygium is below these levels but the patient is symptomatic, both cataract and pterygium surgery can be performed using the IOL values measured before surgery without causing a more significant refractive error. Similar to the findings of this investigation, other studies demonstrate that the border value of the length of pterygium affecting the assessment of pertinent corneal parameters is typically about 2.5mm [13,14]. However, there are few studies on the effect of the specific width and area of pterygium on the cornea, and some

studies have shown that the result value of pterygium is lower than that of the width and area obtained in this paper5. This may be the result of variations in regional variations, lifestyle choices, and health consciousness of the individuals chosen for this study, as well as variations in pterygium incidence, particular clinical indicators, measurement techniques, and IOL calculation formula choice.

The best time to remove a cataract after pterygium surgery is still up for debate. One month following surgery, according to certain research [5,13] the cornea achieved refractive stability. In contrast, it was discovered in other studies8 that the time of corneal refractive stability was correlated with the size of the pterygium; when the pterygium was less than 1/3 of the horizontal distance between the corneal limbus and the pupal limbus, the corneal tissue returned to normal 1 month after surgery, whereas the cornea of the larger pterygium was repaired at least 3 months after surgery. The cornea has an 11.5 to 12.0 mm horizontal transverse diameter. Patients with pterygium lengths less than 4.5 mm were chosen and monitored for at least 3 months following surgery.

Previous research has found no difference in accuracy between the SK-II formula and the SK-T formula in patients with normal ocular axis, however the SK-T formula is much more accurate than the SK-II formula in patients with long ocular axis [15]. However, Hipólito et al. [16] found that the IOL lens degree error evaluated by the SK-T formula is related to anterior chamber depth. The greater the anterior chamber depth, the greater the IOL degree error computed by the SK-T formula. There was no significant difference in this paper between the mean difference of intraocular lens size calculated by SK-T and SK-II formula and the difference of intraocular lens size before and after surgery ($P > 0.05$), but when the intraocular lenses measured by SK-T and SK-II formula before surgery ($P<0.01$), the statistical difference was significant, but there was no significant difference after surgery. Although the results of our study did not express the overall difference in preoperative and postoperative anterior chamber depth and binocular anterior chamber depth, there were significant differences in some patients before and after surgery, and it cannot be ruled out that pterygium also had an impact on the anterior chamber depth, causing errors in the SK-T formula calculation.

The primary limitations of this study include the lack of consideration for the depth of corneal invasion and the morphology of pterygium, as well as the limited number of formulas employed to determine the IOL degree. The influence of pterygium on the measurement of IOL degree may change depending on the morphology of the pterygium, active inflammation, and the depth of corneal invasion, and the results may differ depending on the calculation formula used. Another significant limitation of the study is the limited sample size, which may have an impact on the validity of our findings.

5. Conclusion

In conclusion, pterygium can impair vision and exacerbate corneal astigmatism, and also affects IOL measurements by altering the cornea's horizontal curvature. The size of pterygium is related to the measurement of corneal curvature and IOL to a certain extent. It is advisable to do pterygium surgery prior to cataract surgery in patients who have pterygium complicated by cataract, and to undertake cataract surgery at least three months after pterygium surgery. The length, width, and area of the pterygium have significant guiding relevance for the choice of IOL degree if simultaneous pterygium and cataract surgery is planned.

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