Al-Azhar University Journal
for Virus Research and Studies

Timing of Intraocular Lens Power Calculation Post Pterygium Surgery

Mona El Sayed Ali Hassan*

Department of Ophthalmology, Faculty of Medicine for Girls, Al-Azhar University, Cairo, Egypt

***E-mail: Mirna.farid_fr@hotmail.com**

Abstract

In patients requiring further cataract surgery, the clinical constancy of keratometric parameters after pterygium removal is essential. Consequently, the prober timing of intraocular lens power calculation post pterygium removal is mandatory to establish proper visual and refractive outcome after cataract surgery. The purpose of this research is to learn more about the time of keratometric and refractive stability after pterygium excision using the conjunctival autografting technique, to get a stable refractive and keratometric readings and subsequently, a proper intraocular lens power calculation. This interventional, prospective, and non-randomized study included eighteen eyes of sixteen cases with primary nasal pterygium. Patients with recurrent and pseudo pterygia were excluded. All cases were exposed to complete ocular examination, including UCVA and BCVA, slit lamp examination, applanation tonometry, and autorefractometry. Intraocular lens (IOL) master machine was used for obtaining the keratometric readings and for intraocular lens (IOL) power calculation. Pterygium operation was done under local infiltration anesthesia using the conjunctival autografting procedure. Follow up post-operatively was done at 1 day, 1 week, 1, 3, and 6 months. Changes in UCVA, BCVA, keratometric values and IOL power calculation readings after pterygium surgery were evaluated. There was significant enlargement in mean UCVA and mean BCVA during all the follow up visits after pterygium operation. Besides, there was a significant rise in mean k_1 during all the follow up visits after pterygium surgery. As regards mean K_2 and the mean astigmatic values, they were significantly decreased after surgery. There was statistically significant decrease in mean IOL power at 1, 3, and 6 months postoperatively. Statistically, the differences between mean IOL power at one month, three months, and six months were non-significant. Pterygium excision using the conjunctival autografting technique is associated with postoperative increased K_1, decreased K_2, increased mean keratometric readings and decreased the astigmatic value. Stable IOL power calculation values was achieved one month postoperatively. Consequently, intraocular lens power calculation and cataract surgery must be suspended for at least one month post pterygium operation in eyes with cataract and pterygium.

Keywords: Pterygium, Cataract, Corneal curvature, Keratometric readings, IOL master, Astigmatism, Intraocular lens.

1. Introduction

Liu et al [1] defined pterygium as a benign fibrovascular proliferative of a conjunctival lesion that extends onto the cornea and may induced a major variation in the corneal refractive parameters. Nejima, (2015) [2] reported that the astigmatism secondary to pterygium is caused by cornea distortion and mechanical flattening in the axis of pterygium traction.

Post pterygium removal the corneal keratometry was found to be unstable for a length of time Duangratn et al [3]. It was proved that the corneal curvature increases while corneal astigmatism decreases Kheirkhah [4].

If interventions such as measurement of the intraocular lens, spectacle prescription, or laser keratometric procedure are performed before attaining keratometric stability after pterygium surgery, they may induce residual refractive error and a poor visual outcome Kam et al [5].

Pham et al [6] reported that as pterygium occurs in older patients, so, it is sometimes associated with cataract. Pterygium removal could be done separately or in conjunction with cataract operation Duangratn et al [3]. Pterygium surgery followed by cataract surgery is the best technique according to the study by Ganapathy et al [7]. This method has a benefit over combined pterygium and cataract operation because it induced improved corneal stability and, as a result, greater predictability in intraocular lens (IOL) power calculation. However, most patients choose single-step combination operations over two-step procedures. On the other hand, Kamiya et al [8] mentioned that concurrent pterygium surgery and cataract results in cosmetic improvement, earlier visual recovery, fewer hospital visits and lower overall treatment costs.

Kheirkhah [4] proved that for patients who need consecutive treatments, like as cataract surgery, the clinical stability of keratometric parameters after pterygium excision is critical. They reported that after 1-3 months pterygium operation there were statistically non-significant changes in keratometric power and corneal astigmatism. The purpose of this research is to determine the time of keratometric and refractive stability after pterygium excision using the conjunctival autografting technique, to get a proper intraocular lens power calculation.

2. Patients and Methods

This research is an interventional, prospective, and non-randomized study. It was done at Al-Zahraa University Hospital for 10 months between March 2020 and January 2021. It included 18 eyes of 16 cases [11 males (68.75%) and 5 females (31.25%)) have primary nasal pterygium. Their age was 39.8 $\pm$ 8.1 as mean$\pm$ SD years (Range: 27 - 58 years). 10 (55.6%) cases had right eye pterygium, while 8 cases (44.4%) had left eye. Patients were prepared for pterygium removal with the conjunctival autografting technique.

Inclusion criteria: The study included patients with primary nasal pterygium and associated with irritative symptoms or visual impairment.

Exclusion criteria: Patients with any other collagen diseases, ocular pathology, recurrent pterygium, or pseudo-pterygium.

All patients were subjected to: Taking full history, autorefractometry, best-corrected visual acuity (BCVA), uncorrected visual acuity (UCVA) (BCVA and UCVA were transformed to the decimal visual acuities), assessment of extra-ocular muscles by investigation of ocular motility in the 6 cardinal directions, slit lamp biomicroscopy (for grading of pterygium and for the anterior segment according to its corneal extension) and indirect ophthalmoscopy. Keratometric readings and the value of the IOL power calculation were obtained by the use of the IOL Master machine (AL-Scan NIDEK OPTICAL BIOMETER). Patients were fully knowledgeable about the surgery nature, and each one of them signed an informed consent form ***Pterygium was***

graded based on its size from the limbus into the following: Grade 1 (0 < 2 mm), ***Grade 2*** (2-4 mm), and ***Grade 3*** (> 4 mm).

Operative procedure:

Pterygium excision was performed in all patients using the conjunctival autografting procedure under local infiltration anesthesia. Surgeries were performed under aseptic conditions using the surgical microscope. Topical anesthesia was applied 3 times with a 3 min interval using 0.4 percent boxinate hydrochloride. With a 25-gauge needle, infiltration anesthesia under the pterygium body and subconjunctivally was done using 2% Lidocaine hydrochloride (Xylocaine). After cleaning the eye with a 1:10 dilution of Povidone-iodine (betadine®), a lid speculum was used to offer maximum exposure. The Wescott scissors were used to cut the pterygium base, followed by a blunt dissection of the pterygium body. Avulsion of the head of the pterygium from the cornea was performed in all cases. Pterygium was then excised using the Wescott scissors. A no. 15 Bard Parker blade was used to remove any vestiges of remaining pterygium tissues adhered to the cornea. Minimal cautery was applied to the bleeding scleral vessels to permit the completion of surgery safely and under vision. Cotton buds were used to provide pressure to the ocular surface to reduce bleeding. A caliper was used to measure the size of the conjunctival defect. From the supertemporal quadrant, a conjunctival limbal autograft the same size as the defect was obtained. The graft was flipped over the cornea and located near the bare sclera that had formed at the pterygium excision site. The graft was placed with proper orientation. One superior and one inferior interrupted 10-0 sutures were used to fix the graft to the sclera at the limbus. Rest of the autograft margins were committed with 2-3 interrupted sutures. The supertemporal conjunctival defect was sutured using 3 - 4 interrupted 10-0 sutures. Antibiotic eye drops and ointment were applied locally, and the operated eye was covered with a sterile pad for 24 hours.

Post-operative therapy: post-operatively topical eye ointment once at bedtime for 5 days, topical antibiotic-steroid eye drops (0.3 percent tobramycin and 0.1 dexamethasone) 5 times/day for 15 days, and 0.2 percent sodium hyaluronate eye drops 3 times/ day for 3 weeks were used.

Follow up: It was performed after 1 day, 1 week, 1, 3, and 6 months post-operatively. Patients were tested for BCVA and UCVA (decimal visual acuities), determination the movements of eye in the 6 cardinal directions, autorefractometry, and slit lamp bio-microscopy (to detect cornea healing, the sclera bed, early recurrences or any side effects of pterygium operation as granuloma formation) at each follow up visit. IOL power calculation and keratometric readings were reported at 1, 3, and 6 months post-operatively using the IOL Master machine.

Statistical calculations: Collected results were reviewed, coded, and placed into the statistical program. Quantitative non-parametric as median with inter-quartile range (IQR), meanwhile parametric data was represented as mean, ranges and standard deviations. Percentiles was used to assess the distribution of some parameters. Qualitative variables were represented as number and percentages. In qualitative data Fisher exact and/or Chi-square test were used in comparing groups when the expected count in any cell found < 5. Independent t-test was used to compare between two independent groups with quantitative data and parametric distribution. The p-value was considered non-significant ($P > 0.05$), significant ($P< 0.05$), and highly significant ($P < 0.01$)).

3. Results

This study was objected to determine the time of keratometric and refractive stability after pterygium excision using the conjunctival autografting technique, to get

a stable refractive and keratometric readings and subsequently, a proper intraocular lens power calculation. It included 18 eyes of 16 cases with primary nasal pterygium.

Figure (1): The intraocular lens Master (AL-Scan Nidek Optical Biometer).

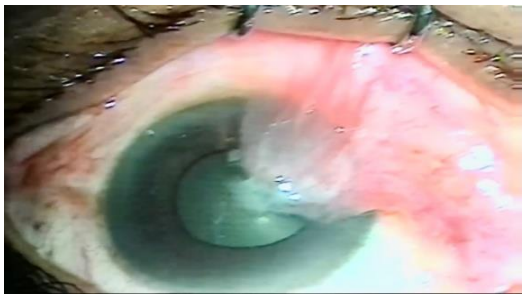

Figure (2): Pterygium Grade 3 preoperatively.

Figure (3): Cutting the base of pterygium using the Wescott scissors.

Figure (4): Avulsion of the head of the pterygium.

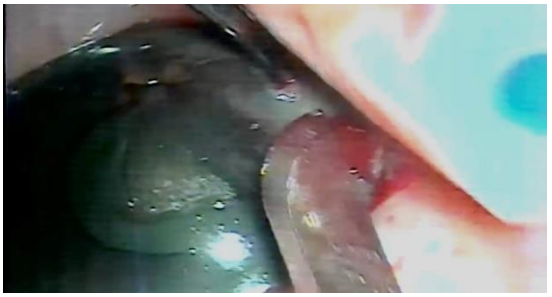

Figure (5): Removal of any remnant from the cornea using a no. 15 Bard Parker blade.

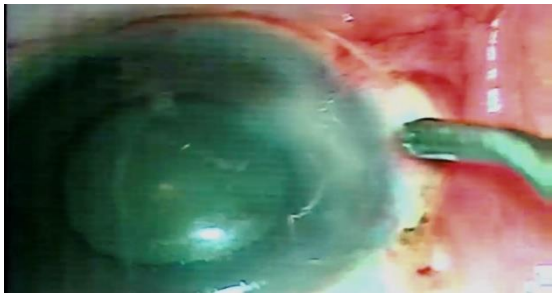

Figure (6): Minimal cautery to the bleeding scleral vessels.

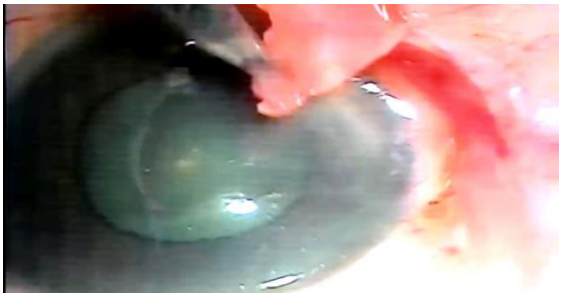

Figure (7): Pterygium excision using the Wescott scissors.

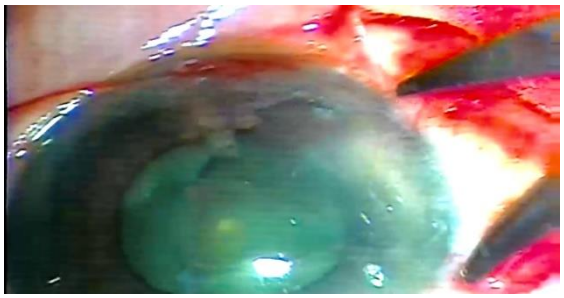

Figure (8): Measuring the area of conjunctival defect after pterygium excision by a caliper.

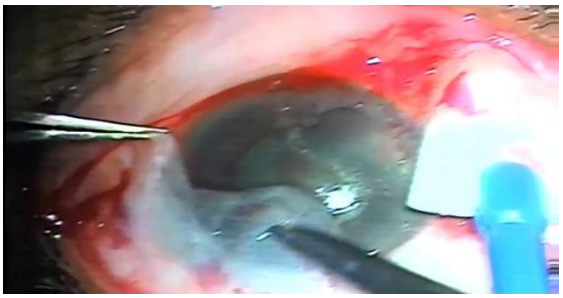

Figure (9): A conjunctival limbal autograft obtained from the supertemporal quadrant.

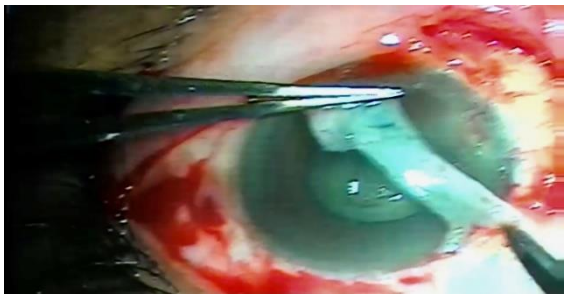

Figure (10): Flipping the graft over the cornea.

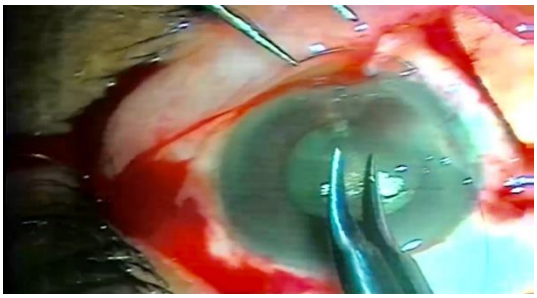

Figure (11): Fixation of the graft to the sclera using interrupted 10-0 sutures.

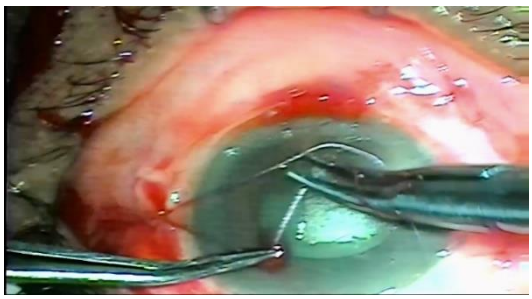

Figure (12): Repair of the supertemporal conjunctival defect using interrupted 10-0 sutures.

Figure (13): The eye at the end of surgery.

Table (1): Comparison of UCVA and BCVA visual acuities pre and postoperatively

		Pre-op	Post-op		
			1 month	3 months	6 months
UCVA	**Mean ± SD**	0.36±0.25	0.44±0.23	0.46±0.31	0.46±0.24
	P value		0.038	0.029	0.022
BCVA	**Mean ±SD**	0.53±0.32	0.59±0.31	0.66±0.28	0.65±0.24
	P value		0.030	0.028	0.026

eleven cases were males (68.75%), and 5 cases were females (31.25%). Their mean age was 39.8 years. Cases were prepared for pterygium removal with the conjunctival autografting procedure. Using the slit-lamp, pterygia were graded into 3

grades according to their extent of corneal involvement. Eight pterygia were in Grade I (44.4%), seven pterygia were in Grade II (38.9%), and three pterygia were in Grade 3 (16.7%).

As displayed in table (1), the mean UCVA ± SD pre-operatively was 0.36 ± 0.25. One month postoperatively, it was 0.44 ± 0.23. Three months postoperatively it was 0.46 ± 0.31. Six months postoperatively it was 0.46 ± 0.24. Statistically, differences between pre and postoperative mean UCVA at one, three months and six months were significant (P values were 0.038, 0.029, and 0.022 respectively).

Mean BCVA pre-operatively was 0.53 ± 0.32. One month postoperatively, it was 0.78 ± 0.28. Three months postoperatively it was 0.87 ± 0.31. Six months postoperatively it was 0.86 ± 0.29. Statistically, differences between pre and postoperative mean BCVA at one month, three months and six months were significant (P = 0.030, 0.028 and 0.026 respectively).

Keratometric readings were obtained by the use of the IOL Master machine. As regards k_1, its mean ± SD pre-operatively was 41.16D ± 1.38. One month postoperatively, it was 43.85D ± 2.61. Three months postoperatively it was 43.92D ± 2.78. Six months postoperatively it was 43.91D ± 2.17. The mean k_1 increased during all the follow up period. Statistically, differences between pre and postoperative mean k_1 at one, three months and six months were significant (P values were 0.016, 0.029 and 0.030 respectively). Statistically, the differences between the mean k_1 at one, three, and six months were non-significant (P values were o.82, 0.86 and 0.71 respectively).

As regards k_2, its mean ± SD pre-operatively was 44.81D ± 2.26. One month postoperatively, it was 44.42D ± 2.15. Three months postoperatively it was 44.38D ± 2.68. Six months postoperatively it was 44.40D ± 2.44. The mean k_2 decreased during all the follow up period. Statistically, differences between pre and postoperative mean k_2 at one, three months and six months were significant (P values were 0.032, 0.038 and 0.041 respectively). Statistically, the differences between the mean k_2 at one, three, and six months were non-significant (P values were o.54, 0.49 and 0.62 respectively).

As regards the mean astigmatic level, before operatively, it was -3.65 D± 1.94. One month postoperatively, it was -0.57 D± 0.26. Three months postoperatively it was -0.46 D± 0.36. Six months postoperatively it was 0.49 D ± 0.31. The mean astigmatic value decreased during all the follow up period. Statistically, there was significant decrease in mean astigmatic value postoperatively as compared to the preoperative level. (P values at one month, three months and six months post-operatively were 0.026, 0.018 and 0.16 respectively). Statistically, the differences between the mean astigmatic value at one, three, and six months were non-significant (P values were 0.82, 0.86 and 0.71 respectively).

As regards the mean intraocular lens power calculation, preoperatively, it was 21.41 ± 3.08. One month postoperatively, it was 20.38 ± 3.82. Three months postoperatively it was 20.35 ± 3.60. Six months postoperatively it was 20.37 ± 3.71. There were decrease of IOL power values postoperatively as compared to the preoperative value. (P values at 1, 3, and 6 months post-operatively were 0.026, 0.027 and 0.022, respectively). Mean IOL power calculation decreased during all the follow up period. Statistically, the decrease in mean IOL power at 1, 3, and 6 months postoperatively were significant. Statistically, the differences between the mean IOL power at 1, 3, and 6 months were non-significant (P values were 0.82, 0.86 and 0.71 respectively).

Table (3): Mean intraocular lens power calculation before and after surgery

		Pre-op (D)	Post-op (D)		
			1 month	3 months	6 months
Mean intraocular lens power calculation	**Mean ±SD**	21.41 ± 3.08	20.38 ± 3.82	20.35 ± 3.60	20.37 ± 3.71
	P value		0.026	0.027	0.022

Recurrences post pterygium operation was found in two eyes out of eighteen (11.1%). They were detected at the follow up visit at the third month postoperatively. No other operative or postoperative complications were reported up to 6 months after surgery.

4. Discussion

vaccination, Pterygium is a conjunctival fibrovascular growth that is wing-shaped and intrudes onto the cornea. It may affect one or both eyes. It may possibly cause blindness in its progressive stage owing to the visual axis invasion, which may have a substantial effect on vision, and may necessitate surgery for visual rehabilitation Pascolini [9]. Pterygium has been proven to be strongly related to sun exposure Chui [10]. Prevalence rises geographically in people subjected to outdoor environments, in rural areas, with increasing age and in male gender Gimeno [11].

Salih and Sharif [12] described the symptoms of irritation, burning sensation, foreign body sensation and lacrimation may go along with the development of pterygium onto the cornea plus an undesirable cosmetic effect. Defective vision may associate pterygium and is secondary to refractive corneal changes Kamiya [8].

Pterygium excision with the conjunctival autografting technique is still the benchmark treatment with lower risk of recurrence than the bare sclera technique Allan [13]. Pterygium excision can be done separately or in conjunction with cataract surgery. It's critical to wait for the cornea to stabilise after sequential surgery, which can take anywhere from 4 to 12 months. Several patients choose single step combined pterygium excision and cataract surgery because it allows for quicker visual recovery, fewer hospital visits, and lower costs Gulani [14], Sharma [15].

Pterygium and cataract occur usually in older patients, so they may be associated together Pham et al [6]. Pterygium removal can be done either separately or in conjunction to cataract surgery. Following cataract surgery after pterygium excision has been chosen over the combined pterygium and cataract surgery in terms of superior corneal stability and consequent greater expectedness of intraocular lens power calculation Ganapathy et al [7]. On the other hand, most patients favor single-step combined procedures over 2-step separate procedures as the single-step procedure provides faster visual recovery and decreases hospital visits with a lower overall treatment cost Kamiya et al [8].

Corneal astigmatism in a pterygium-affected eye may indicate the combined effect of naturally occurring and pterygium-induced astigmatism. The following are some of the proposed mechanisms of pterygium induced astigmatism: first, the mechanical distortion and flattening of the cornea by fractional force of contractile components within the pterygium. Next, the localized tears pooling at the apex of the pterygium which leads to the keratometric observation of corneal flattening Kampitak [16], Welson [17].

Yagmur [18] reported that surgical intervention for pterygium caused a rise in the mean refractive power at 1 month post pterygium surgery, indicating a steepening of the flattened cornea. According to Ozdemir and Cinal [19] the mean corneal refractive power was 42.51±1.99 D during

the pre-operative period, 43.95±1.58 D during early post-operative period, and 43.89±1.8D during late postoperative period.

Our study also showed a statistically substantial rise in k_1 at 1, 3, and 6 months postoperatively in comparison with the pre-operative level. As regards K_2, there was statistically significant decrease in k_2 at 1, 3, and 6 months when compared with to the pre-operative level. The mean keratometric readings increased during all the follow up period. Also, a statistically significant reduction in the astigmatic values at all the follow up visits as compared to the pre-operative level was observed.

Our results agree with the study reported by Sharma [15] who found keratometric and corneal astigmatic stability at one month post pterygium excision. They reported statistically non-significant change in keratometric power and corneal astigmatism at one to three months after the operation.

Kam et al [5] reported that the mean astigmatism and keratometry measured by Scheimpflug tomography post-operation were stable as early as 1 week post pterygium excision. They stated that intervention such as spectacle prescription, laser keratometric procedure, or intraocular lens measurement before obtaining keratometric stability post pterygium surgery could bring about residual refractive error along with a general poor visual outcome.

On the other hand, Shajari [20] recommend follow up of patients for at least 3 months before continuing with sequential refractive procedures. They reported that keratometric changes may follow initial stability observed one month after pterygium surgery. They considered that the genuine change, may be a result of pre-existent dry eye syndrome or to measurement error.

Many studies have found a substantial association between the degree of pterygium extension into the cornea and the extent of produced astigmatism, according to Salih and Sharif [12], indicating that pterygium size is a vital predictor of the extent of induced corneal astigmatism. According to Stern [21] pterygium extendion into > 45% of the corneal radius or within 3.2 mm of the visual axis produces high levels of induced astigmatism, which is remarkably enhanced by successful surgery. Kim et al [22] exemplified a substantial association between the pterygium length and the mean keratometric change post pterygium removal. They found that pterygium of length less than 2.0 mm rarely induces postoperative changes in corneal parameters.

Our results are consistent with Kamiya [8] who evaluated the predictability of IOL power calculation post concurrent pterygium excision by the conjunctival grafting procedure and phacoemulsification surgery. Three months following surgery, they observed a considerable enhancement in BCVA, lower apparent astigmatism, and higher mean keratometry. They found that post pterygium removal, there was a postoperative myopic shift owing to corneal steepening, as pterygium has a tendency to flatten the cornea.

In our study, recurrences after pterygium operation of pterygium were found in two eyes out of eighteen (11.1%). They were detected at the follow up visit at the third month postoperatively. No other operative or postoperative complications were reported up to 6 months after surgery. Wajdi [23], reported that the incidence of recurrence rate in their study using the conjunctival autograft technique for treatment of pterygium was 8%.

Stern [21] revealed that the mean corneal astigmatism is decrease from 5.93 D ± 1.68 to 1.92D ± 1.68 D. Yagmur [18] established that mean topographic astigmatism decreased from 4.6 D ± 3.02 D pre-operatively to 2.33 D ±2.26 D. These results agree more with our findings. Our study showed that the mean intraocular lens power calculation, preoperatively, it was

21.41 D. Postoperatively, it was 20.38 D, 20.35 D, and 20.37 D at 1, 3, and 6 months respectively. There were increase of IOL power values postoperatively as compared to the preoperative value. Statistically, the increase in mean IOL power at one month, three months and six months postoperatively were significant. There was stable IOL power calculation starting one month postoperatively, as the differences between the mean IOL power at one month, three months, and six months were statistically non-significant.

The explanation of the decreased IOL power calculation after pterygium surgery is due to the steepening effect of pterygium surgery, that releases the flattening effect which the pterygium head exerts on the cornea.

5. Conclusion

Pterygium excision using the conjunctival autografting technique is associated with postoperative increased keratometric readings and decreased corneal astigmatism. Stable corneal and refractive parameters is achieved one month postoperatively. Consequently, intraocular lens power calculation and cataract surgery should be postponed for at least one month post pterygium surgery in patients suffering from pterygium and cataract.

References

1- Liu T, Liu Y, Xie L, et al.: Progress in the pathogenesis of pterygium. Curr Eye Res. 2013;38(12):1191 – 1197.

2- Nejima R, Masuda A, Minami K, et al.: Topographic changes after excision surgery of primary pterygia and the effect of pterygium size on topographic restoration. Eye Contact Lens. 2015;41(1):58 – 63.

3- Duangratn N, Wasee T, Vannarut S: Time to Keratometric Stability After Pterygium Excision and the Associated Factors: A Clinical Perspective, Clinical Ophthalmology downloaded from https://www.dovepress.com/by 102.41.227.213 on 23-Dec-2021.

4- Kheirkhah A, Safi H, Nazari R, et al.: Effects of pterygium surgery on front and back corneal surfaces and anterior segment parameters. Int Ophthalmol. 2012;32(3):251 – 257.

5- Kam KW, Kuan TA, Belin MW, et al.: Long-term stability of keratometry, scheimpflug-derived true net power, and total corneal refractive power after primary pterygium excision. Cornea. 2017;36 – 44.

6- Pham TQ, Wang JJ, Rochtchina E, Mitchell P: Pterygium, pinguecula, and 5-year incidence of cataract. Am J Ophthalmol. 2005, 139: 1126-8.10.1016/j.ajo.2004.12.004.

7- Ganapathy K, Dinu K: Outcomes of sequential pterygium and cataract surgery: a prospective case series. IP Int J Ocul Oncol Oculoplasty. 2018, 4:30-5.10.18231/2455-8478.2018.0010

8- Kamiya K, Shimizu K, Iijima K, Shoji N, Kobashi H: Predictability of intraocular lens power calculation after simultaneous pterygium excision and cataract surgery. Medicine (Baltimore). 2015,94: e2232. 10.1097/MD.0000000000002232.

9- Pascolini D, Mariotti SP: Global estimates of visual impairment: Br J Ophthalmol. 2012, 96:614 - 8. 10.1136/bjophthalmol-2011-300539.

10- Chui J, Di Girolamo N, Wakefield D, and Coroneo MT: The pathogenesis of pterygium: current concepts and their therapeutic implications. Ocul Surf. 2008; 6: 24 - 43.

11- Gimeno AT, Costa LM and Ayala G: Pre-operative factors influencing success in

pterygium surgery. BMC Ophthalmology. 2012; 12(38): 1 – 7

12- Salih PAKM and Sharif AFMD. Analysis of pterygium size and induced corneal astigmatism. Cornea. 2008; 27(4): 434 - 438.

13- Allan BD, Short P, Crawford GJ, Barrett GD, Constable IJ: Pterygium excision with conjunctival autografting: an effective and safe technique. Br J Ophthalmol. 1993,77:698-701.10.1136/bjo.77.11.698

14- Gulani A, Dastur YK: Simultaneous pterygium and cataract surgery. J Postgrad Med. 1995, 41:8 - 11.

15- Sharma B, Bajoria S, Mishra M, et al.: Refractive Outcomes of Simultaneous Pterygium and Cataract Surgery with Fibrin Glue. Cureus. 2021, 13 (11): e19857. DOI 10.7759/cureus.19857.

16- Kampitak K: The effect of pterygium on corneal astigmatism. J Med Assoc Thai. 2003; 86: 16 - 23.

17- Welson, N, Samy M, Gaafar, A, et al.: The effect of pterygium surgery on corneal topography. International Journal of Medicine, 2020; 113(1): 026.

18- Yagmur M, Altan A, Ozcan et al.: Visual acuity and corneal topographic changes related with pterygium surgery. J Refract Surg. 2005; 21: 166 - 170.

19- Ozdemir M and Cinal A: Early and late effects of pterygium surgery on corneal topography. Ophthalmic Surg Laser Imaging. 2005; 36: 921 - 925.

20- Shajari M, Cremonese C, Petermann K, et al.: Comparison of axial length, corneal curvature, and anterior chamber depth measurements of 2 recently introduced devices to a known biometer. Am J Ophthalmol. 2017; 178:58 – 64. doi: 10.1016/j.ajo.2017.02.027.

21- Stern G and Lin A.: Effect of pterygium on induced cormeal topographical abnormalities. Cornea 1998; 17: 23 - 27.

22- Kim SW, Park S, Im CY, Seo KY, Kim EK: Prediction of mean corneal power change after pterygium excision. Cornea. 2014, 33:148-53. 10.1097/ICO.0000000000000036.

23- Wajdi FM: Evaluation of Conjuncival Autografting Augmented with Mitomycin C Application Versus Ologen Implantation in the Surgical Treatment of Pterygium. J Ophthalmol. 2021. RMID: 33505715.