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ORIGINAL ARTICLE

THE EFFECT OF LIMBAL RELAXING INCISIONS ON 1-WEEK POSTOPERATIVE IN K1 AND K2 VALUES

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ABSTRACT

Introduction: *Limbal Relaxing Incisions (LRI) is a surgical technique used to correct astigmatism during cataract surgery. This technique used to reduce the steepness of the corneal curvature in a particular meridian. LRI can be performed alone or in combination with phacoemulsification.*

Methods: *This prospective study aimed to investigate the effect of Limbal Relaxing Incisions (LRI) on corneal astigmatism in patients who underwent phacoemulsification cataract surgery. Five patients were included in this study, and preoperative and 1-week postoperative keratometry values (K1=flat keratometry and K2=steep keratometry) were measured using the IOL Master. Paired t-test analysis was used to compare the changes in K1 and K2 values before and after LRI.*

Results: *Five patients with the mean age 39.8 years (range: 22 to 76 years) and corneal astigmatism 3.12 D (range: 2.25 to 4.66 D) were underwent LRI and cataract surgery. The mean preoperative K1 and K2 values were 42.12 D and 46.44 D, respectively, while the mean 1-week postoperative K1 and K2 values were 42.60 D and 45.80 D, respectively. Paired t-test analysis showed a statistically significant decrease in K2 values (p = 0.025) but no significant change in K1 values (p = 0.329).*

Conclusion: *This study showed there were no significant difference between pre and postoperative of K1 and showed a significant decrease in K2 on IOL Master examination. The wide age range of the included patients may have influenced the effectiveness of LRI in reducing astigmatism. Further study with more subjects are required.*

Keywords*: Limbal Relaxing Incision, Cataract Surgery, Astigmatism*

INTRODUCTION

Astigmatism, which is defined as the difference in the refractive error between two principal meridians of the eyeball leading to a corresponding asymmetric refraction of light rays, is the most common type of refractive error.[1,2] The total extent of astigmatism usually refers to the astigmatism of the eye as a complete ocular system (total astigmatism, TA), which can be measured by objective or subjective refraction.[3]

Research in Iran reported that the prevalence of astigmatism was 32.2% (95% confidence intervals (CI): 30.2-34.2). Astigmatism significantly increased from 14.3% in the under 15-year-old age group to 67.2% in the age group of over 65-years old.[4] Astigmatism is

influenced by genetic and ethnic factors and its prevalence has been reported from 30% among old people in Myanmar to 77% in Indonesia. Astigmatism is the most common refractive error in certain countries such as Indonesia.[5,6] The prevalence of astigmatism in the general population was found to increase with advancing age, mainly because of age- related changes in refractive index gradients within the crystalline lens.[7]

The following risk factors were reported to contribute to the development of astigmatism in adulthood: age, sex, race, education status, pre-existing refractive errors, and various other factors, such as urban versus rural population, degree of nuclear and cortical cataract, axial length, and presence of internal astigmatism.[7]

Astigmatism affects patients' visual acuity and contrast sensitivity at all light levels.[8] Astigmatism correction is generally achieved using spectacles, contact lenses, toric intraocular lenses, toric implantable collamer lenses, or corneal refractive surgery.[9] If left uncorrected, patients may suffer from distorted vision, eyestrain, and diplopia.[10] Furthermore, patients with uncorrected astigmatism also suffer from decreased vision-related quality of life, increased risk of falls, night-time driving difficulties, and decreased overall well- being.[11–14]

Limbal relaxing incisions (LRI) are partial thickness incisions made at the corneal periphery for the treatment of corneal astigmatism. LRI is a safe and an inexpensive procedure, which is simple for experts to perform. It can effectively reduce astigmatism up to 3.0 D and result in a rapid visual rehabilitation.[15]

Individuals 70 years or older had higher odds (odds ratio [OR], 2.5) of astigmatism compared with individuals in the 50- to 59-year age group.[16] In addition to an increased risk of astigmatism, increasing age is also associated with an increased risk of cataracts. The prevalence of any cataract ranged from 5% in people aged 40–49 to 71.7% in those older than 80. The rate of cataract in adults 70–79 years old (62.9%) is two times and 12 times of that in adults 60– 69 years old (29.9%) and 40–49 years old (5.0%), respectively.[17]

This study aims to analyze the clinical outcomes of cataract patients with astigmatism undergoing phacoemulsification and LRI.

METHODS

This prospective study aimed to investigate the effect of LRI on corneal astigmatism in patients who underwent phacoemulsification cataract surgery. Five patients were included in

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this study, and preoperative and 1-week postoperative keratometry values (K1=flat keratometry and K2=steep keratometry) were measured using the IOL Master. Paired t-test analysis was used to compare the changes in K1 and K2 values before and after LRI.

RESULTS

Table 1. Evaluation before and after limbal relaxing incisions

Variable	Value	*p*
Age	39.8(22-76)	-
K1		0.329
• Pre-operative	41.12 D	
• Post-operative	42.60 D	
K2		**0.025**
• Pre-operative	46.44 D	
• Post-operative	45.80 D	

Dependent T-test; significant p<0.05

Table 2. K1 and K2 value before operation procedure

	OD K1 / K2	OS K1 / K2	OD Axis K1 / K2	OS Axis K1 / K2	ΔK OD / OS
1	41,74/ 48,40	41,82/ 48,19	174 / 84	179 / 89	7,73 / 7,74
2	42,72/ 43,49	41,98/ 45,73	176/8 6	11/10 1	7,83 / 7,70
3	43,66/ 45,55	42,99/ 45,24	90 / 0	93 / 3	7,54 / 7,60
4	-/-	42,51/ 45,18	-/-	87 / 177	- /7,7 1
5	43,38/ 45,67	43,27/ 46,42	18 / 108	143 / 53	7,59 / 7,54

Five patients with the mean age 39.8 years (range: 22 to 76 years) and corneal astigmatism 3.12 D (range: 2.25 to 4.66 D) were underwent LRI and cataract surgery. The mean preoperative K1 and K2 values were 42.12 D and 46.44 D, respectively, while the mean 1-week postoperative K1 and K2 values were 42.60 D and 45.80 D, respectively. Paired t-test analysis showed a statistically significant decrease in K2 values (p = 0.025) but no significant change in K1 values (p = 0.329).

Table 3. K1 and K2 value after operation procedure

	OD K1 / K2	OS K1 / K2	OD Axis K1 / K2	OS Axis K1 / K2	ΔK OD / OS
1	41,98/ 46,86	42,24/ 46,68	174 / 84	3 / 93	7,63 / 7,61
2	42,72/ 43,49	42,08/ 45,73	172/82	13/103	7,82 / 7,66
3	43,72/ 45,86	43,27/ 45,61	16 / 106	165 / 75	7,56 / 7,63
4	-/-	42,67/ 45,30	-/-	84 / 174	- /7,68
5	44,48/ 45,30	43,1/ 46,11	18 / 108	138 / 48	7,51 / 7,58

DISCUSSION

In this study it was found that the LRI treatment caused a significant decrease in the K2 value of astigmatism patients. Keratometry is the measurement of the corneal radius of curvature. Keratometry attempts to predict the total corneal power based on the measurement

of the anterior corneal surface. The measurements are normally recorded along two orthogonal meridians, giving the maximum and minimum corneal powers. These are known as K-values or corneal Ks. The difference between the K-values is the corneal astigmatism. Keratometry can be acquired with a variety of instruments either manually or via automated keratometres. Keratometry is a critical measurement in intra-ocular lens power calculation because errors in measurements are matched 1:1 to refractive outcomes. K1 is known as the flattest central keratometry value (vertical corneal meridian), while K2 is known as the steepest central keratometry value (horizontal corneal meridian).[18]

Current reports show variable reduction effects on astigmatism by performing LRIs. Budak et al reported an absolute decrease in mean astigmatism of 44 percent, Bayramlar et al. 52 percent, Kaufmann et al. 25 percent, and Carvalho el al. 50 percent.[19,20] Kim et al reported a 49 percent reduction effect for refractive total astigmatism, and 32 percent for corneal astigmatism. The reduction effects of astigmatism in the corneal plane to be less than that in the refractive plane. One possible explanation for this may be that the high astigmatism seen in some patients may originate from not only the cornea but also the lens. Therefore, removal of the lens might have an additional effect on reduction of astigmatism. Budak et al. reported that regression in astigmatic correction mostly occurs in eyes with more than 3.5 D of astigmatism. Because of the general regression trend for corneal incisions in cataract surgery and of LRIs for lower astigmatism (less than 3 D), long term regression appears less likely to occur.[20] Finally, it can be assumed that if an incisional procedure, such as LRIs, is added during phacoemulsification surgery, third-order aberrations in cornea are only partially affected. If the unaltered indices of corneal irregularities are taken into account, it may be assumed that LRIs can be considered safe, thus not causing significant irregularities in corneal morphology.[21]

LRIs have been used to correct pre- existing corneal astigmatism at the time of cataract surgery. LRIs are effective in eyes with low to moderate, and even high, astigmatism. These incisions also appear to cause less distortion and irregularity on corneal topographies than corneal relaxing incisions and arcuate keratotomy. They can provide more rapid postoperative vision and carry less risk of inducing glare and discomfort.[22] In a study that conducted by Ganekal S, et al, the use of LRIs during phacoemulsification significantly reduced preoperative astigmatism. Additionally, the astigmatic correction with LRIs stabilized early and remained stable over 6 months with no regression noted. The CDVA of 6/9 or better was achieved in 99.5% of cases at the last follow-up. Most complications after LRIs were mild and clinically nonsignificant.[23] Ravikumar K, et al in his research assessing the efficacy of LRI in the

treatment of astigmatism who also underwent phacoemulsification found that there was 71.8% decrease in central corneal astigmatism after limbal relaxing incisions. Therefore it can conclude that limbal relaxing incisions can be used effectively in conjunction with cataract surgery to reduce the astigmatism <3 D at the corneal level and aids us in providing spectacle free optimal distance vision in patients.[24]

LRIs appear to have potential advantages by causing less distortion and irregularity on corneal topographies and less variability in refraction as they are placed at the limbus. They can provide earlier stability in postoperative vision and may carry a lower risk of inducing glare and discomfort. Precise placement on the axis is not as critical as in arcuate keratotomy because the incisions are more peripheral and longer. They are also more forgiving with incision depth than arcuate keratotomy and are easier to perform.[20] Carvalho et al. have shown that LRI performed during phacoemulsification surgery is a safe, effective, and stable procedure to reduce pre-existing corneal astigmatism.[19] However, we know that LRIs are surgeon-dependent and result in some degree of variability and unpredictability, which causes an increase in higher-order aberrations (HOAs) and, occasionally, in dry eye and healing problems.[21]

CONCLUSION

Limbal relaxing incisions performed on astigmatism patients undergoing cataract surgery were able to reduce the K2 keratometry value on IOL Master examination after 1 week of intervention.

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