INTERNATIONAL JOURNAL OF SOCIAL HEALTH
https://ijsh.ph/index.php/rp
Volume 3 Number 6 June 2024 E-ISSN: 2984-7079

Refractive Outcomes Comparison in Limbal Relaxing Incision Based on Incision Depth in Managing Corneal Astigmatism During Cataract Surgery

Herdyanto, A.[1]*, Sagara, F.[2], Widatama, I.M.S.[3], Wulandari, R.[4]
Department of Opthalmology, dr. Murjani General Hospital [1,2,3], Klinik Mata KMU, East Java, Indonesia[4]
Email: alexander.herdyanto@gmail.com

KEYWORDS
Limbal Relaxing Incision, Corneal Astigmatism, Cataract Surgery

ABSTRACT
Introduction: Prevalence of clinically significant astigmatism of more than 1D can be found in 20 to 50% of the population who undergo cataract surgery. During phacoemulsification surgery, astigmatism could be corrected by a toric intraocular lens (IOL) or incisional technique such as a limbal relaxing incision (LRI). LRI are safe and inexpensive procedures thus resulting in satisfying outcomes with the surgeon's precise phacoemulsification incision and accurate LRI arc position, which most appropriate treatment choice for surgeons in rural areas that have problematic access to IOL supply. Objectives: To compare refractive outcomes of the LRI technique with incision depths of 500um and 600um using a diamond knife corresponding with phacoemulsification cataract removal. Methods: A prospective cumulative interventional case study included 30 eyes of consecutive cataract corneal astigmatic patients with power 1.0D undergoing LRI and phacoemulsification. Length, numbers, and arc position of LRI were calculated on the LRI Calc application to obtain the best results in minimal astigmatism residual. Uncorrected visual acuity, intraocular pressure, and keratometry cylinder were also analyzed before surgery, Day 1, Day 7, and 1-Month post-operation. Results: Day-1 follow-up keratometry showed that corneal astigmatism still fluctuated, day-7 follow-up was even better with significant improvement in visual acuity. 1-Month post-operation has reached target correction. Moreover, visual acuity and residual astigmatism were better at 600um incision depth. Conclusion: When toric IOLs are not available or contraindicated, LRI could be a good option in correcting astigmatism with better refractive outcomes trend in 600um incision depth. LRI results better be evaluated on day 7 and 1 month post-LRI, which may be due to a more stable corneal surface.

DOI:

Corresponding Author: Herdyanto, A.*
Email: alexander.herdyanto@gmail.com

INTRODUCTION

The leading cause of blindness worldwide is cataracts, although it is curable through cataract extraction surgery (Chen, Xu, Chen, & Yao, 2021). Recently, advanced technology has become more accurate, has minimal complications, and is less invasive. Phacoemulsification cataract removal nowadays aims for optimal vision, while in the past surgeons were focused on improving visual acuity (Benítez Martínez, Baeza Moyano, & González-Lezcano, 2021). Prevalence of patients with astigmatism more than 1.0 diopters (D) who undergo cataract surgery was found in 20 to 50% of patients (Arriola-Villalobos et al., 2021).

Correction for astigmatism degree greater than 2.0D may be beneficial in reducing distortion, and remarkably uncorrected visual acuity improvement (Agarwal, Thornell, Hodge, Sutton, & Hughes, 2018). There are several methods in correcting corneal astigmatism during phacoemulsification, such as post-operative visual correction by laser ablative, toric intraocular lens (IOL) or intraoperative

incisional technique known as limbal relaxing incision (LRI).3,4. In addressing corneal astigmatism during phacoemulsification, such as for post-operative visual correction.

Previous studies found that LRI possibly corrects astigmatism in between 0.5D to 3.0D (Nanavaty, Bedi, Ali, Holmes, & Rajak, 2017). Since the incision area is made in the limbus of the cornea, the central cornea integrity will not be affected, and less post-operative risk such as glare or discomfort. The recovery process also sped up due to the minimal incision of LRI did not have an impact on the central cornea surface (Starr et al., 2019).

OBJECTIVES

This study aims to evaluate the refractive outcomes, as residual astigmatism diopters after the LRI technique throughout cataract phacoemulsification surgery within different incision of diamond knife depths 500um and 600um.

The objective of this study is to assess the refractive outcomes, specifically residual astigmatism in diopters, following the LRI technique during phacoemulsification cataract surgery, comparing different incision depths of 500μm and 600μm with a diamond knife.

METHOD

Longitudinal prospective interventional case series conducted on all patients who underwent cataract surgery at Murjani General Hospital, Sampit, Central Kalimantan, Indonesia over a period of April to May 2023 consecutively in a total of 30 eyes from 30 patients. Then, patients were randomly assorted into two groups. Group 1 for 600um LRI incision depth, and group 2 for 500um LRI incision depth. All patients who undergo cataract surgery and the LRI technique have received information and written informed consent about the benefits and complications that may occur (Roberts et al., 2019).

Inclusion criteria in the study were all cataract patients who underwent surgery with perioperative regular corneal astigmatism more than 1 diopter (D).

Then, the study excluded patients who have previous eye conditions that may interfere with visual axis measurement such as pterygium, keratitis, uveitis, synechiae, glaucoma, retinal diseases, and other ocular problems that may impact corrected visual acuity post-cataract phacoemulsification extraction simultaneously with LRI technique.

One day before the operation, all patients went through screening including visual acuity using a Snellen chart, slit lamp examination, non-contact tonometry, autorefraction keratometry (Huvitz HRK-7000A), and ultrasound biometry. Afterward, the LRI Calc application was used in calculating the length and arc of the LRI incision.

There were two surgeons who performed all surgeries under topical anesthesia, dr. Frisma and Dr. Made. A sterilized corneal ink marker was used to target the arc and position of the LRI incision after the cataract extraction was completed (Hirnschall et al., 2014). Phacoemulsification incision was in a 200-degree position for the right eye, and a 20-degree position for the left eye for both 600um and 500um incision depth groups. Subsequently, the diamond knife was used to create the LRI incision based on the marking, with depth adjustment of 600um and 500um.

Follow-up post-operative was done on Day 1, Day 7, and 1-Month post-operation. Every patient who undergoes cataract surgery is treated with oral mefenamic acid, methylprednisolone, and ciprofloxacin combined with polidemisin eyedrop (dexamethasone, neomycin sulfate, and polymyxin). In each visit, every patient was measured for their visual acuity, monitored intra-ocular pressure, autorefraction keratometry, and slit lamp examination to make sure of any complications post-operative (Mohammed, Dubay, & Bhola, 2023).

Then, remain cylinder diopters were obtained and processed using Microsoft Excel for Macintosh Spreadsheets and IBM SPSS. A statistically significant data was considered when p-value of 0.05 or less. A chi-square test was processed to determine between 500um and 600um incision groups.

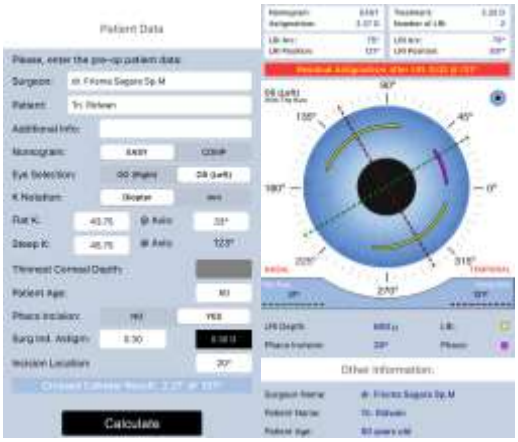

Figure 1. Example of Patient Data and LRI Incision Planning (LRI Calc Application)

RESULT AND DISCUSSION

Table 1 revealed the demographic of patients enrolled a total of 30 patients with 30 consecutive eyes eligible for phacoemulsification surgery combined with LRI technique. The mean age of patients undergoing surgery was similar in both groups 500um and 600um by 56.07 ± 10.28 and 58.73 ± 8.49 respectively. Baseline cylinder diopters pre-operation screening was also similar in both groups by -1.81 ± 0.55 and -1.91 ± 0.95D for 500um and 600um groups.

The surgeon found no significant complications thus may impact visual acuity outcomes post-operative such as corneal edema, endophthalmitis, or even retinal detachment. All 30 patients also did not require any secondary intervention. As seen in Table 1, all subjects have fulfilled post-operation follow-up until 1 month period.

As described in Table 1, residual astigmatism power one day after the surgical done was increased in both groups by -2.67 ± 1.11D in the 500um group, and -2.17 ± 0.67D in the 600um group compared to screening baseline. Then, one week later the cylinder refractive measurement showed a down-trend by -1.73 ± 0.31D and -1.30 ± 0.62D in 500um and 600um groups accordingly. With a significant p-value of 0.002, 600um was eminent to 500um incision depth at a week post-operation. Subsequently, a one-month follow-up after the LRI procedure was done, revealed a lowered cylinder diopter in both groups with a significant p-value of 0.001. Clearly seen that 600um incision depth was superior in eliminating astigmatism compared to 500um by -0.70 ± 0.72D and -1.25 ± 0.40D respectively.

Figure 1 explains the trend of residual refractive outcomes measured by cylinder diopters (CD) in both groups. Clearly shown that the residual astigmatism was significantly better in 600um incision compared to 500um.

Table 1.
Patient Characteristics, Pre and Post-operative Cylinder Refraction of Both Groups

	500um (Mean ± SD)	600um (Mean ± SD)	p-value
Age	56.07 ± 10.28	58.73 ± 8.49	0,394
Sex			
Male	10 ± 66.7	9 ± 60	.705*
Female	5 ± 33.3	6 ± 40	
Pre-Op CD	-1.81 ± 0.55D	-1.91 ± 0.95D	0,77
Pre-Op X	92.27 ± 69.86	77.13 ± 50.50	0,561
1-Day Post-Op CD	-2.67 ± 1.11D	-2.17 ± 0.67D	0,123
1-Day Post-Op X	87.73 ± 60.82	74.20 ± 47.14	0,48

7-Day Post-Op CD	-1.73 ± 0.31D	-1.30 ± 0.62D	**0,002**
7-Day Post-Op X	84.20 ± 66.66	70.40 ± 47.17	0,708
30-Day Post-Op CD	-1.25 ± 0.40D	-0.70 ± 0.72D	**0,001**
30-Day Post-Op X	82,53	69,73	0,724

SD = standard deviation; Pre-op = pre-operation; Post-op = post-operation CD = cylinder diopters; X = axis; (*)Chi-square

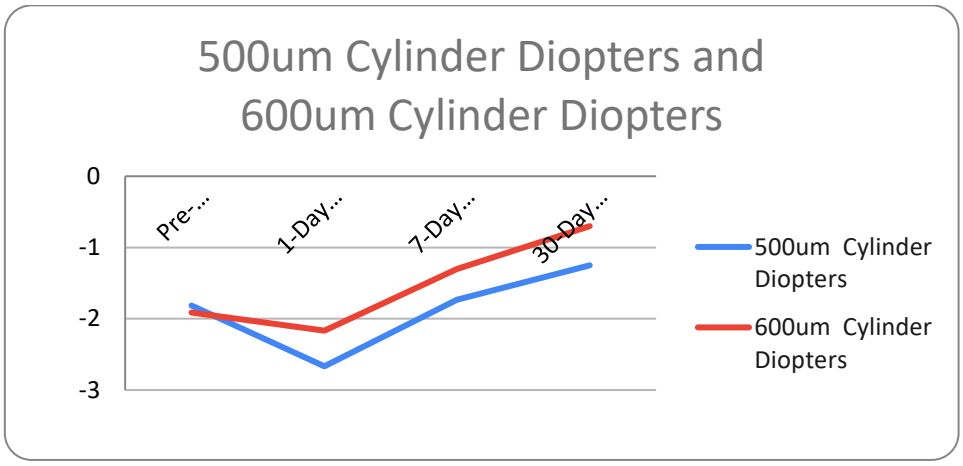

Figure 1. The trend of Refractive Astigmatism Distribution of Both Groups

Advanced technology made cataract surgery goals shift from improving vision to gaining perfect visual acuity (Wang, Stem, Oren, Shtein, & Lichter, 2017). Nowadays, customer demand and surgeon goal in performing phacoemulsification cataract removal is the least refractive outcome error.

As shown in Table 1, data shows randomization thus in line with our design of the study. Yet, the mean age of the 600um group is slightly higher compared to the 500um. As people age, the incidence of against-the-rule astigmatism will increase (Beesley & Elliott, 2024). Still, 600um could achieve better outcomes in lowered astigmatism residual

All patients were assessed for their residual astigmatism with autorefraction keratometry every follow-up 1-day, 7-day, and 1-month post phacoemulsification. As shown in Figure 1, the trend of astigmatism refraction in 1-day post-operation spiked, this phenomenon may be due to corneal instability caused by incision intra-operative. Cylinder diopters one week after surgery still fluctuated yet statistically significant (p-value = 0.002). Nevertheless, the trend was going downwards due to the cornea surface commencing to heal. Eventually, one monthly evaluation showed even lower astigmatism refractive outcome residual and statistically significant (p-value = 0.001) and reached target astigmatism correction better in the 600um group.

Our study revealed that both 500um and 600um LRI depth could reduce initial astigmatism significantly. Nonetheless, the 600um group statistically proved better results. It is well known that some patients complained about glare in toric IOL, while patients included in the study were not reported to have post-operative distortion, glare, or other vision discomfort.

With residual astigmatism of less than 1.0D in the 600um group and no overcorrections reported, LRI could be effective in eliminating astigmatism during cataract phacoemulsification surgery. A previous study by Lake et al. also discovered that toric IOL has slightly better refractive outcomes while the trend was not statistically significant.

This study was done on rural hospitals on Borneo island thus have difficult access to custom toric IOL supply (Cochrane, 2017). LRI is a practical, easy method, and low-cost procedure that possibly enhances visual acuity significantly for patients' ongoing cataract-removal surgery. In spite of LRI not

achieving full correction, the residual cylinder diopters were still tolerable compared to overcorrection (Kieval et al., 2020).

Some limitations are still found in this study. There is no control group, hence trend of refractive astigmatism in the untreated LRI patients remains unknown (Soh et al., 2020). Larger subjects are needed to be included in the study to express the real population and applicability. Longer follow-up evaluations are also important to ensure the residual astigmatism is permanent without any rebound, and to make sure no other complications in the future (Dick & Gerste, 2021).

CONCLUSION

In summary, LRI with an incision depth of 600um could be a good option whereas toric IOL is not available or contraindicated. Besides being inexpensive, LRI is also an easy application technique, and thus does not require any expert surgeon in daily practice. Evaluation of LRI outcome preferably done 7 days after the surgery due to cornea stability, moreover one month post-surgery was even better due to improvement in cornea recovery.

REFERENCES

Agarwal, S., Thornell, E., Hodge, C., Sutton, G., & Hughes, P. (2018). Visual outcomes and higher order aberrations following LASIK on eyes with low myopia and astigmatism. *The Open Ophthalmology Journal*, 12, 84.

Arriola-Villalobos, P., Burgos-Blasco, B., Fernández-Vigo, J. I., Ariño-Gutiérrez, M., Burgos-Blasco, P., Carmona-González, D., & Fernández-Pérez, C. (2021). Biometry data and prevalence of corneal astigmatism in caucasian spanish candidates for cataract surgery. *Journal Français d'Ophtalmologie*, 44(1), 76–83. Retrieved from https://doi.org/10.1016/j.jfo.2020.03.025

Beesley, J., & Elliott, D. B. (2024). Changes in ocular astigmatism with age: A longitudinal study. *Ophthalmic and Physiological Optics*, 44(1), 71–77.

Benítez Martínez, M., Baeza Moyano, D., & González-Lezcano, R. A. (2021). Phacoemulsification: Proposals for improvement in its application. In *Healthcare* (Vol. 9, p. 1603). MDPI.

Chen, X., Xu, J., Chen, X., & Yao, K. (2021). Cataract: Advances in surgery and whether surgery remains the only treatment in future. *Advances in Ophthalmology Practice and Research*, 1(1), 100008. Retrieved from https://doi.org/10.1016/j.aopr.2021.100008

Cochrane, G. (2017). *Anthropology in the mining industry: community relations after Bougainville's civil war*. Springer.

Dick, H. B., & Gerste, R. D. (2021). Future Intraocular Lens Technologies. *Ophthalmology*, 128(11), e206–e213. Retrieved from https://doi.org/10.1016/j.ophtha.2020.12.025

Hirnschall, N., Gangwani, V., Crnej, A., Koshy, J., Maurino, V., & Findl, O. (2014). Correction of moderate corneal astigmatism during cataract surgery: Toric intraocular lens versus peripheral corneal relaxing incisions. *Journal of Cataract and Refractive Surgery*, 40(3), 354–361. Retrieved from https://doi.org/10.1016/j.jcrs.2013.08.049

Kieval, J. Z., Al-Hashimi, S., Davidson, R. S., Hamilton, D. R., Jackson, M. A., LaBorwit, S., … Donaldson, K. (2020). Prevention and management of refractive prediction errors following cataract surgery. *Journal of Cataract & Refractive Surgery*, 46(8), 1189–1197.

Lake, J. C., Victor, G., Clare, G., Porfírio, G. J., Kernohan, A., & Evans, J. R. (2019). Toric intraocular lens versus limbal relaxing incisions for corneal astigmatism after phacoemulsification. *Cochrane Database of Systematic Reviews*, 2019(12). Retrieved from https://doi.org/10.1002/14651858.CD012801.pub2

Mohammed, I., Dubay, S., & Bhola, R. (2023). Optometry meets ophthalmology-cycloplegic refraction and examination under general anaesthesia in a paediatric high myope. *Adv Ophthalmol Vis Syst*, 13(1), 20–24.

Nanavaty, M. A., Bedi, K. K., Ali, S., Holmes, M., & Rajak, S. (2017). Toric Intraocular Lenses Versus Peripheral Corneal Relaxing Incisions for Astigmatism Between 0.75 and 2.5 Diopters During

Cataract Surgery. *American Journal of Ophthalmology*, 180, 165–177. Retrieved from https://doi.org/10.1016/j.ajo.2017.06.007

Roberts, H. W., Wagh, V. K., Sullivan, D. L., Hidzheva, P., Detesan, D. I., Heemraz, B. S., … O'Brart, D. P. S. (2019). A randomized controlled trial comparing femtosecond laser–assisted cataract surgery versus conventional phacoemulsification surgery. *Journal of Cataract and Refractive Surgery*, 45(1), 11–20. Retrieved from https://doi.org/10.1016/j.jcrs.2018.08.033

Soh, Y. Q., Kocaba, V., Weiss, J. S., Jurkunas, U. V, Kinoshita, S., Aldave, A. J., & Mehta, J. S. (2020). Corneal dystrophies. *Nature Reviews Disease Primers*, 6(1), 46.

Starr, C. E., Gupta, P. K., Farid, M., Beckman, K. A., Chan, C. C., Yeu, E., … Mah, F. S. (2019). An algorithm for the preoperative diagnosis and treatment of ocular surface disorders. *Journal of Cataract and Refractive Surgery*, 45(5), 669–684. Retrieved from https://doi.org/10.1016/j.jcrs.2019.03.023

Wang, S. Y., Stem, M. S., Oren, G., Shtein, R., & Lichter, P. R. (2017). Patient-centered and visual quality outcomes of premium cataract surgery: a systematic review. *European Journal of Ophthalmology*, 27(4), 387–401.