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Refractive Outcomes After Lasik In Mixed Astigmatism Patients

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Abstract

Introduction: Refractive errors are the third leading cause of visual impairment. Laser in situ keratomileusis has become the most popular refractive procedure performed today because of its safety, efficacy, quick visual recovery and minimal patient discomfort. Achieving manifest spherical equivalent within ±0.5D after LASIK in mixed astigmatism patients is challenging.

Aim & objective: To evaluate refractive and visual outcomes of laser in-situ keratomileusis (LASIK) by cross cylinder method in mixed astigmatism patients.

Methodology: In this prospective study, we evaluated refractive and visual outcomes of laser in-situ keratomileusis (LASIK) by cross cylinder method in 37 eyes with mixed astigmatism of 20 patients. Visual outcomes, changes in refraction and astigmatism were evaluated at 12 months.

Results & discussion:

Mean age of the patient was 25.84 ± 6.14 years. Male to female ratio was 2.33:1. Post operatively statistically significant improvement was observed in astigmatism ($p<0.05$). Spherical equivalent was -1.41 ± 0.1 pre operatively. Post operatively it was -0.14 ± 0.2. In our study, At 12 months after LASIK, 89.19% (33/37) of eyes had uncorrected distance visual acuity of 6/6 or better.

Keywords: Cross cylinder, LASIK, mixed astigmatism

INTRODUCTION

Astigmatism is a refractive condition of eye in which vision is blurred due to inability of eye to focus a single point on the retina."

"Astigmatism is Greek word. ("a" meaning absence and "stigma" meaning point). It is a refractive error (ametropia) that occurs when parallel rays of light entering the nonaccommodating eye are not focused on the retina [American Academy of Ophthalmology (AAO), 2007]". [1] It can be due to irregular curvature of cornea and lens or retinal pathology. Corneal astigmatism is most common among these.

Refractive error is the second most common cause of treatable blindness around the world. [2] "Astigmatism (more than 0.5 diopters) is a commonly encountered refractive error, accounting for about 13 per cent of the refractive errors of the human eye. [3] According to study by Wolfram C et al, 32.3% adult population had refractive cylinder of 0.5 diopter (D) [4]. Moderate to high degree astigmatism was found in 4.61% (cylindrical error of 2.5D or more) [5].

Uncorrected refractive error can lead to problems in a person's quality of life related to vision and makes it difficult for them to perform daily routine activities. While spectacles and contact lenses are usually the first choice of correcting the refractive error for myopic persons. In recent years, refractive surgery is gaining popularity, even among persons who have worn contact lenses. It is now the most common

surgery in the world as an option for correcting refraction.

Refractive error surgery decreases subject's dependence on spectacles or contact lenses. Popularity and success of these surgeries are related to easy availability, quick procedure, favourable results of uncorrected vision, and few side effects of these surgeries. They generally entail three Photorefractive keratectomy methods: LASIK (Laser insitu keratomileusis), LASEK (Laser sub epithelial keratomileusis), and PRK (Photo Refractive Keratectomy).

In LASIK, an automated microkeratome is used to create a corneal flap. The stromal bed is ablated with excimer laser, depending on the type and amount of refractive error in accordance with the predetermined data that has been entered in the excimer laser system. Under this precise control the laser reshapes the curvature of the cornea to correct myopia, hypermetropia or astigmatism. The flap adheres to the underlying stroma within 24 hrs. as a result of the endothelial pump. LASIK is performed on an outpatient basis.

Very few studies have been reported for outcome of moderate to high astigmatic treatment. [6-11]

Azar et al studied all kinds of astigmatism. They used different combinations of ablations like combined spherical and hyperopic cylindrical treatment, combined hyperopic spherical and myopic cylindrical treatments, combined Cross-Cylinder and spherical equivalent and combined cylindrical treatments. [12]

Azar et al found that In mixed astigmatism, the greatest ablation depth was in Group 5 (combined hyperopic spherical and myopic cylindrical treatments). [12] In treating compound hyperopic and mixed astigmatism cylindrical approaches cause reduced ablation depth. Central and peripheral corneal tissue ablation was greatest by applying hyperopic sphere combined with a myopic cylinder. Various studies were carried out for treatment strategies of astigmatism. The differences between cross cylinder and bioteric treatment are not clear. [13-15]

Precise determination of pre operative magnitude and axis of refractive cylinder, adequate centration of elliptical ablation and proper understanding of biomechanics of corneal healing are the important factors for surgical correction with excimer Lasik. [16-20]

There is a need to study the refractive errors and visual outcomes after cataract surgery in mixed astigmatism. So we planned to evaluate refractive and visual outcomes of laser in-situ keratomileusis (LASIK) by cross cylinder method in mixed astigmatism patients.

Aims & Objectives:

To evaluate refractive and visual outcomes of laser in-situ keratomileusis (LASIK) by cross cylinder method in mixed astigmatism patients.

Materials and Methods:

A Prospective Hospital-based Study was conducted at Mahatme Group of Eye hospitals, Nagpur. Study population was patients who underwent LASIK for mixed astigmatism.

Inclusion Criteria: 1. Patients with mixed astigmatism 2. Patients in the age group of 20-50 years 3. Patients willing to participate in the study

Exclusion criteria: 1. Patients with other ocular pathology 2. Patients with previous corneal surgery 3. Patients with connective tissue diseases 4. Immunocompromised patients (poor healing, chances of infection) 5. Pregnant females 6) Keratoconus or any ectasia

Study was approved by ethical committee. A valid written consent was taken from patients after explaining study to them.

Data was collected with pre tested questionnaire. Data included demographic characteristic like age, gender, clinical history and clinical examination. Preoperative ophthalmic examination, corneal topography, ultrasound pachymetry, and wavefront aberration measurements were taken. Necessary pre operative investigations were done. Ophthalmic examinations included refraction, Uncorrected Distance Visual Acuity (UDVA) and Corrected Distance Visual Acuity (CDVA).

37 eyes of 20 patients with mixed astigmatism were included. All patients were operated by a single senior consultant. Topical anaesthesia was given with 0.5% tetracaine. A small flap was cut into the epithelium using femtosecond laser. This allowed the epithelium to move. For operating all patients Nidek EC 5000 excimer Laser (Nidek Co. Gamagori Japan) was used.

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Excimer Laser was fired and the layers were reshaped. All patients were treated by LASIK surgery using cross cylinder method. It was a three-stage treatment. Firstly, the prescribed subjective cylinder (figure 2) is split into two halves Cneg (negative cylinder) and Cpos (positive cylinder) of equal magnitude and opposite sign. The positive cylinder is treated at 90 degrees to the negative cylinder. The residual refractive error is compensated by a spherical treatment. [19] The flap in the epithelium was put back in its place over the rest of the cornea tissue to let it heal with the rest of the tissues. The ablation profile included aspheric component for treatment of spherical defect (radially symmetric abberations) and toric component for treatment of astigmatism (linearly symmetris abrrations).

Topical gatifloxacin and prednisolone is given for 2 weeks and lubricants for 3 months.

1. SEQ = Ssubj+0.5 x Csubj
2. Cneg = 0.5 x Csubj
3. Cpos = 0.5 x ⎪Csubj⎪

- SEQ : spherical equivalent Cneg : negative cylinder
- Cpos : positive cylinder Ssubj : subjective sphere
- Csubj : subjective cylinder

Cross cylinder formula

Outcome of the study was evaluated by measuring astigmatism at 12 months after surgery. Visual outcome was measured using snellen's chart. Refraction was evaluated at 12 months.

Data was entered in excel sheet. Statistical analysis was done using SPSS version 22.

Results:

In our study 37 eyes of 20 patients with mixed astigmatism were included. Mean age of the patient was 25.84 ± 6.14 years.

Table 1 shows age wise distribution of the patients. Maximum patients were in the age group of 18-25 years (60%) followed by 26-30 years (20%). In the age group of 36-40 years (15%) patients were seen. In age group of 31-35 years one patient was observed. (table 1) In our study 6 were females and 14 males. Male to female ratio was 2.33:1. (fig 1)

Table 2 shows ophthalmic variables of mixed astigmatism patients in pre and post operatively. The Preoperative and postoperative astigmatism was 2.66 ± 0.1 and 0.4 ± 0.31 respectively. Post operatively statistically significant improvement was observed ($p<0.05$). Spherical equivalent was -1.41 ± 0.1 pre operatively. Post operatively it was -0.14 ± 0.2. The difference between the two group was statistically significant ($p<0.05$). Preoperative sphere was between -7 D and 3.5D (mean 0 D).

Fig 2 shows Comparison of UCVA (Uncorrected Distance Visual acuity) pre and post operatively in mixed astigmatism patients. Pre operatively 37 eyes (100%) had UCVA of worse than 6/6. At 12 months after LASIK, 89.19% (33/37) of eyes had uncorrected distance visual acuity of 6/6 or better. This difference was statistically significant ($p<0.05$). Out of the 4 patients with UDVA of worse than 6/6, one eye had CDVA of 6/6 and remaining three eyes had CDVA of 6/9.In our study 91.89% had manifest spherical equivalent within ±0.5D. 91.9% had residual refractive cylinder within ±0.50 D of intended correction.

Discussion:

Present study was a Prospective Study was conducted patients who underwent LASIK for mixed astigmatism to evaluate refractive and visual outcomes of laser in-situ keratomileusis (LASIK) by cross cylinder method. The major reasons for treating refractive errors are to improve a patient's visual acuity, visual function, and visual comfort.

In our study 37 eyes of 20 patients with mixed astigmatism were studied. All patients were treated by LASIK surgery using cross cylinder method. Mean

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age of the patient was 25.84 ± 6.14 years. Male to female ratio was 2.33:1.

The Preoperative and postoperative astigmatism was 2.66 ± 0.1 and 0.4 ± 0.31 respectively. Post operatively statistically significant improvement was observed ($p<0.05$). Spherical equivalent was -1.41 ± 0.1 pre operatively. Post operatively it was -0.14 ± 0.2. The difference between the two group was statistically significant ($p<0.05$). Preoperative sphere was between -7 D and 3.5D (mean 0 D).

In our study, At 12 months after LASIK, 89.19% (33/37) of eyes had uncorrected distance visual acuity of 6/6 or better. This difference was statistically significant ($p<0.05$). In our study 91.89% had manifest spherical equivalent within ±0.5D. 91.9% had residual refractive cylinder within ±0.50 D of intended correction.

Our results indicated that LASIK in myopic eyes with high cylinder lead to good, predictable refractive and visual outcomes.

Our results are better than those reported in the study by Schallhorn et al. [22] In their study, at 3 months after LASIK, 83.8% of eyes had uncorrected distance visual acuity of 20/20 or better, 90.3% had manifest spherical equivalent within ±0.50 D, and 79.1% had residual refractive cylinder within ±0.50 D of intended correction. A statistically significant correlation was found between the error of magnitude (arithmetic difference in the magnitudes between surgically induced refractive correction and intended refractive correction) and the intended refractive correction ($r=0.26$, $P<0.01$).

In contrast to our study, Hasegawa et al [8] had done a study where refractive cylinder remained stable up to 12 months postoperatively in patients with moderate-to-high myopic astigmatism.

Similar study by Igarashi et al [7] found significant regression in sphere but no statistically significant change in cylinder between 1-week and 1-year exams.In their study they observed, Postoperatively, the mean spherical refraction changed significantly from 0.38 ± 0.80 D at 1 week to −0.13 ± 0.90 D at 1 year ($P<.001$, Wilcoxon signed-rank test). The mean cylindrical refraction showed no significant change (−0.67 ± 0.54 D at 1 week to −0.63 ± 0.63 D at 1 year) ($P=.54$).

James J et al studied LASIK correction of spherical hyperopia, hyperopic astigmatism, and mixed astigmatism with the LADARVision excimer laser system and found that for mixed astigmatism at 6 and 12 months, UCVA was 20/40 or better in 92.6% and 94.4% of eyes, respectively. The MRSE was within 0.50 D of intended in 64.9% and 73.7% of eyes, respectively, and within 1.00 D in 87.7% and 94.7% of eyes, respectively. A loss of two lines of BSCVA occurred in 1.9% and 0.0% of eyes, respectively, and no eyes lost more than two lines. [23]

The predictability and safety of LASIK with the optimized aspheric transition zone (OATz) and cross-cylinder technique were evaluated for the surgical correction of myopia with 1.00 to 4.25 diopters (D) of astigmatism in a study by Tamer Gamaly. He observed that Postoperatively, 78.3% (58/74) of eyes achieved uncorrected visual acuity (UCVA) of 20/20 or better, and 97.3% (72/74) of eyes achieved UCVA of 20/40 or better. [24]

In a study by Hashemi Seyed et al conducted on 15 eyes of 8 patients with mixed astigmatism. They were treated by cross cylinder ablation method. They found that Before surgery, the range of astigmatism was -1.50 to -6.50 diapers (D) (mean-3.50±1.36 D) and the spherical component was between +0.25 and +3.50D (mean+1.33±1.30 D). Mean cylinder and spherical refraction reduced from -3.50 and +1.33D before surgery to -0.76 and +0.36 D after surgery, respectively. Three months after surgery, 11 eyes out of 15 (72.7%) had less than -1.00D of astigmatism, all eyes had uncorrected visual acuity (UCVA) of 20/30 or better and 53% of the eyes had an UCVA of 20/20. [25]

Conclusion: LASIK for the correction of mixed astigmatism is effective.

References:

1. Dandona R, Dandona L. Refractive error blindness. Bull World Health Organ. 2001;79:237–243.
2. American Academy of Ophthalmology (AAO), 2014-2015.
3. Porter J, Guirao A, Cox IG & Williams DR. (2001). Monochromatic aberrations of the human eye in a large population. J Opt Soc Am A Opt

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Image Sci Vis, Vol.18, No.8, (August 2001), pp.1793-1803).

4. Wolfram C, Höhn R, Kottler U, Wild P, Blettner M, Bühren J, et al. Prevalence of refractive errors in the European adult population: the Gutenberg Health Study (GHS). Br J Ophthalmol. 2014 Jul;98(7):857–61.
5. Prevalence of corneal astigmatism in patients having routine cataract surgery at a teaching hospital in the United Kingdom. - Abstract - Europe PMC [Internet]. [cited 2020 Mar 1]. Available from: https://europepmc.org/article/med/21840163.
6. Arbelaez MC, Vidal C, Arba-Mosquera S. Excimer laser correction of moderate to high astigmatism with a non-wavefront-guided aberration-free ablation profile: Six-month results. J Cataract Refract Surg. 2009 Oct;35(10):1789–98.
7. Igarashi A, Kamiya K, Shimizu K, Komatsu M. Time course of refractive and corneal astigmatism after laser in situ keratomileusis for moderate to high astigmatism. J Cataract Refract Surg. 2012 Aug;38(8):1408–13.
8. Hasegawa A, Kojima T, Isogai N, Tamaoki A, Nakamura T, Ichikawa K. Astigmatism correction: Laser in situ keratomileusis versus posterior chamber collagen copolymer toric phakic intraocular lens implantation. J Cataract Refract Surg. 2012 Apr;38(4):574–81.
9. Ivarsen A, Næser K, Hjortdal J. Laser in situ keratomileusis for high astigmatism in myopic and hyperopic eyes. J Cataract Refract Surg. 2013 Jan;39(1):74–80.
10. Alió JL, Plaza-Puche AB, Martinez LM, Torky M, Brenner LF. Laser in situ keratomileusis using optimized aspheric profiles and cyclotorsion control to treat compound myopic astigmatism with high cylinder. J Cataract Refract Surg. 2013 Jan;39(1):28–35.
11. Katz T, Wagenfeld L, Galambos P, Darrelmann BG, Richard G, Linke SJ. LASIK versus photorefractive keratectomy for high myopic (> 3 diopter) astigmatism. J Refract Surg Thorofare NJ 1995. 2013 Dec;29(12):824–31.
12. Azar DT, Primack JD. Theoretical analysis of ablation depths and profiles in laser in situ keratomileusis for compound hyperopic and mixed astigmatism. J Cataract Refract Surg. 2000 Aug;26(8):1123–36.
13. Gatinel D, Hoang-Xuan T, Azar DT. Three-dimensional representation and qualitative comparisons of the amount of tissue ablation to treat mixed and compound astigmatism. J Cataract Refract Surg. 2002 Nov;28(11):2026–34.
14. Hasaballa MA., Ayala MJ, Alío JL. (2003). Laser in situ keratomileusis correction of mixed astigmatism by bitoric ablation. Journal of Cataract and Refractive Surgery, 29: 1889-1895
15. Doane JF, Slade SG. (2003) Treatment of Astigmatism. Custom Lasik: Surgical Techniques and Complications. Slack incorporated, 657-659
16. Chernyak DA. Iris-based cyclotorsional image alignment method for wavefront registration. IEEE Trans Biomed Eng. 2005 Dec;52(12):2032–40.
17. Ghosh S, Couper TA, Lamoureux E, Jhanji V, Taylor HR, Vajpayee RB. Evaluation of iris recognition system for wavefront-guided laser in situ keratomileusis for myopic astigmatism. J Cataract Refract Surg. 2008 Feb;34(2):215–21.
18. Khalifa M, El-Kateb M, Shaheen MS. Iris registration in wavefront-guided LASIK to correct mixed astigmatism. J Cataract Refract Surg. 2009 Mar;35(3):433–7.
19. Shen EP, Chen W-L, Hu F-R. Manual limbal markings versus iris-registration software for correction of myopic astigmatism by laser in situ keratomileusis. J Cataract Refract Surg. 2010 Mar;36(3):431–6.
20. Azar DT, Chang J-H, Han KY. Wound healing after keratorefractive surgery: review of biological and optical considerations. Cornea. 2012 Nov;31 Suppl 1:S9-19.
21. Ortueta D, Arba Mosquera S, Häcker C. Treating Mixed Astigmatism ◆ A Theoretical Comparison and Guideline for Combined Ablation Strategies and Wavefront Ablation. In: Astigmatism-optics, Physiology and Management. 2012.

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22. Schallhorn SC, Venter JA, Hannan SJ, Hettinger KA. Clinical outcomes of wavefront-guided laser in situ keratomileusis to treat moderate-to-high astigmatism. Clin Ophthalmol Auckl NZ. 2015 Jul 13; 9:1291–8.

23. James J. Salz, MD, Christy A. Stevens, OD LADARVision LASIK Hyperopia Study Group. LASIK correction of spherical hyperopia, hyperopic astigmatism, and mixed astigmatism with the LADARVision excimer laser system. American Academy of Ophthalmology. Sept 2002;109 (9): P 1647-57

24. Tamer Gamaly, MD. LASIK with the Optimized Aspheric Transition Zone and Cross-Cylinder Technique for the Treatment of Astigmatism from 1.00 to 4.25 Diopters. Journal of Refractive Surgery. 2009;25(10):S927-S930.

25. Hashemi Seyed Hasan, Miraftab S.M. Cross-cylinder ablation Lasik for mixed astigmatism. SPRING 2004, Volume 9 , Number 3 (35); Page(s) 221-28.

Table 1: Distribution of patients according to age group

Sr no	Age group (years)	No of patients	Percentage
1	18-25	12	60%
2	26-30	04	20%
3	31-35	01	5%
4	36-40	03	15%
5	Total	20	100%

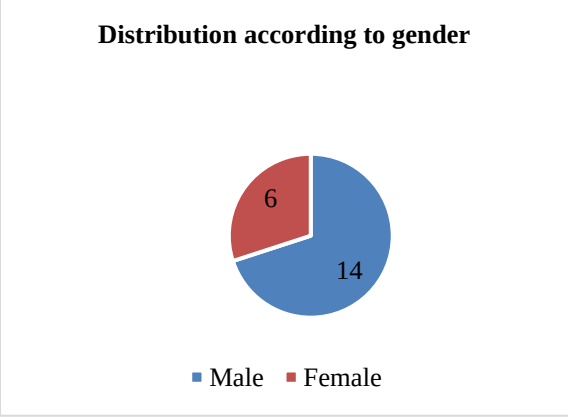

Fig 1: Distribution of patients of mixed astigmatism according to gender

Table 2: Comparison of ophthalmic variables of mixed astigmatism patients pre and postoperative

Variables	Pre operative	Post operative	P value
Astigmatism	2.66 ± 0.1	0.4 ± 0.31	**<0.05**
Spherical equivalent	-1.41 ± 0.1	-0.14 ± 0.2	**<0.05**

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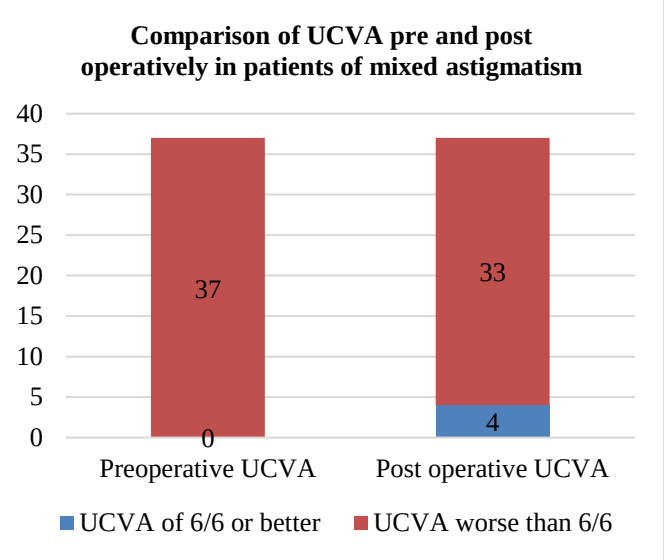

Fig 2: Comparison of UCVA pre and post operatively in patients of mixed astigmatism

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