International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

Preoperative Keratometry Affecting Visual Outcome in Myopic LASIK

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Received: 11/05/2015 *Revised: 08/07/2015* *Accepted: 09/07/2015*

ABSTRACT

Background: Multiple factors affect the visual outcome after myopic Laser in situ keratomileusis. However, the effect of preoperative keratometry still remains controversial.
Aim: To assess the visual outcome in low, moderate and high myopia based on preoperative keratometry values.
Setting & Design: A prospective, serial, comparative, interventional study conducted in Department of Ophthalmology, Dhiraj Hospital, Vadodara.
Materials and methods: Our study included 170 eyes of 111 patients. Based on the preoperative spherical equivalent (SE), all eyes were divided into low (≤ -3 D), moderate (> -3 D to ≤ -6 D) and high (> -6 D) myopia and based on preoperative average keratometry (K) each group was further divided into flat (< 43 D) and steep (> 46 D) sub groups.
Statistical Analysis: SPSS program (version 12.0)
Results: At 6 months postoperatively changes in keratometric value ΔK showed significant difference (P <0.05) while changes in spherical equivalent ΔSE showed no significant difference (P >0.05) in all three groups. UCVA of 20/20 at 6 months postoperative in low myopia group was 83.3% (flat K) and 92.6% (steep K), in moderate myopia group was 60.7% (flat K) and 79.3% (steep K), in high myopia group 44.3% (flat K) and 52.2% (steep K).
Conclusion: Eyes with steeper corneas showed better visual outcomes in all three groups, though undercorrection was observed in steep subgroup of low myopia.

Keywords: LASIK, myopia, keratometry, visual outcome.

INTRODUCTION

Laser in situ keratomileusis (LASIK) has become a popular surgical alternative for the correction of myopia. According to *Yun-I Chen et al*, the significant predictors of visual outcome after LASIK surgery are manifest refraction, preoperative keratometry, optical zone and undercorrection. [1] The relationship between preoperative keratometry and visual outcome in LASIK has been studied mostly in high myopia and hyperopia. [2,3,4] The present study aims at prospectively analyzing the visual prognosis based on preoperative keratometry in low myopia ≤ -3 D, moderate myopia > -3D to ≤ -6 D, high myopia > -6 D.

MATERIALS AND METHODS

All myopic patients above the age of 18 years who reported to us from January 2013 to January 2014 were selected on the basis of inclusion and exclusion criteria. Patients with an average K either <43 D or >46 D were included and evaluated for early keratoconus changes with Rabinowitz KISA index%. [5] Patients with KISA index >100% were excluded. Cut-off values of variables for KISA index > 100% were taken as average K value >47.2 D, the inferior-superior (I-S) value >1.4 D, keratometric astigmatism (AST) >1.5 D, relative skewing of the steepest radial axes (SRAX) >21°. Patients with prior history of ocular surgery or ocular trauma, presence of nuclear sclerosis, any posterior segment abnormalities, known cases of glaucoma, any active corneal infection, immunodeficiency diseases, active connective tissue disorder and pregnant/lactating females were not included in the study.

All individuals underwent a complete ophthalmic examination including a detailed ocular and medical history, uncorrected visual acuity (UCVA), best corrected visual acuity (BCVA), subjective correction with and without cycloplegia, tear film tests, slitlampbiomicroscopy, intra ocular pressure with applanation tonometer(AATM-5001), ultrasonic pachymetry (ACCUTOME AccuPach VI), corneal topography (CARL ZEISS ATLAS Model 9000), and fundus evaluation.

Eyes were compared between average K <43.0 D (flat) and average K of >46.0 D (steep), where K average is (Kflat +Ksteep)/2. All eyes were targeted for emmetropia and treated with MEL 80 Excimer Laser System. Eyes were matched according to preoperative age and spherical equivalent. Residual stromal thickness (RST) was calculated after deducting flap thickness from postoperative corneal thickness at 1week. Change in K (ΔK) was calculated as preoperative minus postoperative average K. Change in SE (ΔSE) was calculated as postoperative SE minus preoperative SE.

All procedures were performed by a single surgeon. A Moria M2 Evolution microkeratome was used to create a corneal flap. The flap diameter was between 8.5-9.25 mm and thickness was 90 or 130 µm. A superior hinge was made in all cases. Optical Zone ranged from 6 -6.5 mm with treatment zone 2.2 mm more than the optical zone. The photo ablation was carried out with Mel 80 excimer laser (193 nm wavelength Argon-Fluoride, Carl Zeiss Meditech). The stability of the corneal flap and adherence to the corneal stroma was checked following surgery, and patients were usually sent home with topical steroid-antibiotic, topical antibiotic and topical lubricating eye drops.

Postoperative examinations were done at 1 week, 1 month and 6 months. On every visit the patient underwent a detailed eye examination including uncorrected and best-corrected visual acuity, intraocular pressure, pachymetry, topography and slit lamp examination.

Ethics: This study was conducted after obtaining approval by Institutional Ethical committee. This was a prospective, interventional and comparative study conducted adhering to the Declaration of Helsinki.

Statistics: Statistical analysis was performed using the SPSS program (version 12.0). Means were compared using the unpaired t-test (2 tailed), while qualitative data were analyzed using the chi-square test. Mean values of collected data were compared between groups at different time intervals using Repeated Measures Analysis of Variance test (repeated measures ANOVA). Statistical significance is kept at 5% level in this study.

RESULTS

In our study, we included 170 eyes of 111 patients, out of which 64 were males and 47 were females. No significant age (P > 0.05) difference between flat and steep groups was noted while significant difference was noted between average keratometric value (P <0.05) of two matched cohort groups. (Table I) On comparison of flat and steep subgroups of low, moderate and high myopia preoperative spherical equivalent and pachymetry were statistically comparable (P > 0.05). There was significant difference present in preoperative average K value (P < 0.05) within flat and steep groups. Ablation depth and residual stromal thickness was statistically comparable between flat and steep subgroups of low, moderate and high myopia. To detect early keratoconus Rabinowitz's KISA% index was used in all patients. [5] (Table II) at postoperative 6 months no significant difference were noted in spherical equivalent (P >0.05) between flat and steep subgroups for low, moderate and high myopia. There was significant difference in keratometric value (P <0.05) at 6 months between flat and steep in all three groups of myopia. Changes in keratometric value ΔK showed significant difference in low, moderate and high myopia while changes in spherical equivalent ΔSE showed no significant difference in all three groups. (Table III)

Table I Demographic characteristics

Demographics	Flat group	Steep group
Patients (n)	58	53
Eyes (n)	88	82
Male:female	3:2	4:3
Age (Years) (Mean ± SD) (Range)	24.38 ± 3.68(20 to 34)	25.67 ± 5.13 (20 to 36)
Keratometry (D) (Mean ± SD) (Range)	42.27 ± 0.19 (39.9 to 42.9)	46.26 ± 0.02 (46.02 to 47.06)

SD = Standard Deviation, D = Diopter

Table II Preoperative characteristics comparison within three groups

Preoperative characteristics (Mean ± SD)	Low myopia		Moderate myopia		High myopia	
	Flat	Steep	Flat	Steep	Flat	Steep
Age (Years)	26.13 ± 3.78	25.14 ± 2.17	23.53± 3.14	24.62 ± 6.99	24.4± 3.49	25.15 ± 4.61
Spherical equivalent (D)	-2.17 ± 0.49	-2.24 ± 0.33	-4.78 ± 0.76	-4.79 ± 0.68	-9.54 ± 2.31	-9.2 ± 2.93
Keratometry (D)	42.19 ± 0.68	46.33 ± 0.29	41.49± 0.79	46.54 ± 0.20	42.01± 0.706	46.60 ± 0.31
Pachymetry (μm)	510.07 ± 15.28	506.96 ± 52.42	513.57 ± 25.64	521.76± 24.68	518.2 ± 35.96	507.81 ± 27.91
Ablation depth (μm)	39.07 ±15.81	41.33 ± 17.17	61.29 ± 19.39	62.93 ± 8.17	91.5 ± 19.84	88.38 ±26.44
RST (μm)	341 ±11.85	335.63 ± 22.77	330.96 ± 21.57	338.83 ± 18.07	306.36 ± 38.13	306.11 ± 20.85
KISA index >100%	0	0	0	0	0	0

RST = Residual stromal thickness, D = Diopter, μm = micrometer
Low myopia ≤ -3.00 D, Moderate myopia >-3.00 to ≤-6.00 D, High myopia > -6.00 D
KISA%=(K)×(I−S)×(AST)×(SRAX)×100300

TABLE III Postoperative results at 6 months in all three groups

Postoperative outcome (Mean ± SD)	Low myopia		Moderate myopia		High myopia	
	Flat	Steep	Flat	Steep	Flat	Steep
Spherical equivalent (D)	-0.14 ± 0.18	-0.22 ± 0.25	-0.28 ± 0.54	-0.25 ± 0.30	-0.99 ± 1.07	-0.60 ± 1.29
Keratometry (D)	40.33 ± 1.04	43.99 ± 0.23	39.32 ± 0.97	42.65 ± 1.42	39.06 ± 2.92	40.4 ± 1.44
ΔK (D)	1.86 ± 0.37	2.34 ± 0.27	2.17 ± 1.48	3.89 ± 1.49	3.95 ± 2.66	6.20 ± 1.46
ΔSE (D)	2.03 ± 0.49	2.32 ± 0.68	4.5 ± 0.94	4.54 ± 0.53	8.55 ± 2.29	8.6 ± 2.8

SE = Spherical equivalent, D = Diopter
$\Delta K = K_{avg(preop)} - K_{avg(postop)}$, $\Delta SE = SE_{postop} - SE_{preop}$
Low myopia ≤ -3.00 D, Moderate myopia >-3.00 to ≤-6.00 D, High myopia > -6.00 D

Figure I, II and III shows percentage of eyes achieving uncorrected visual acuity of 20/20 and 20/30 at postoperative 6 months. In all three groups statistically significant difference between flat and steep subgroups was noted. In all three groups steeper corneas showed better visual outcomes than flatter corneas. Figure IV, V and VI show significant improvement in uncorrected visual acuity after LASIK surgery but minor changes were noted till 6 months follow up. Figure VII, VIII and IX shows significant reduction in spherical equivalent after LASIK surgery and minor regression in all groups.

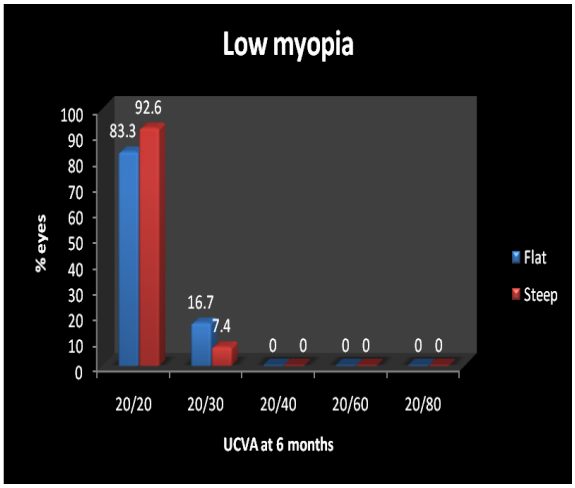

Figure I. Comparison of uncorrected visual acuity at 6 months post-operative between flat and steep groups of low myopia

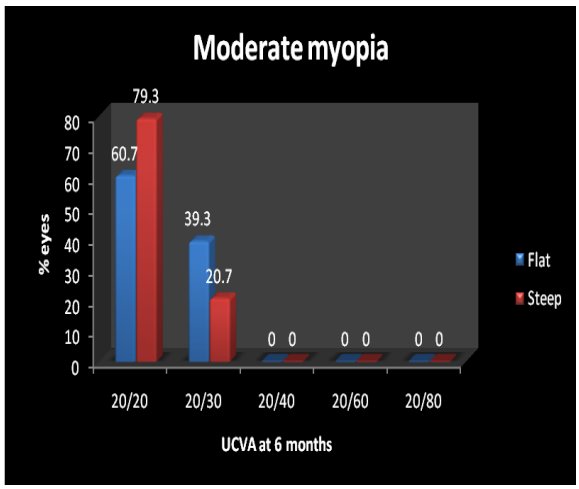

Figure II. Comparison of uncorrected visual acuity at 6 months post-operative between flat and steep groups of moderate myopia

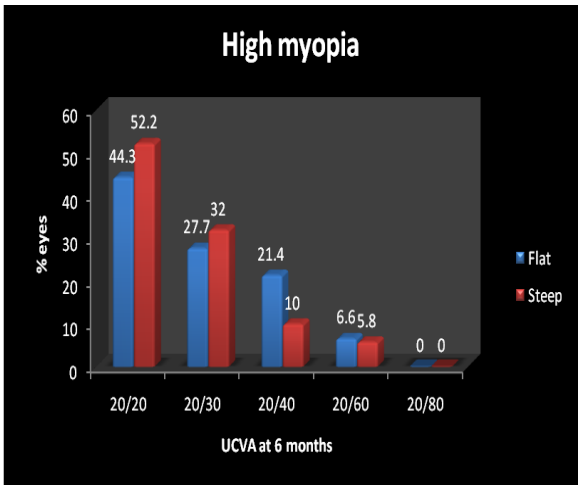

Figure III. Comparison of uncorrected visual acuity at 6 months post-operative between flat and steep groups of high myopia

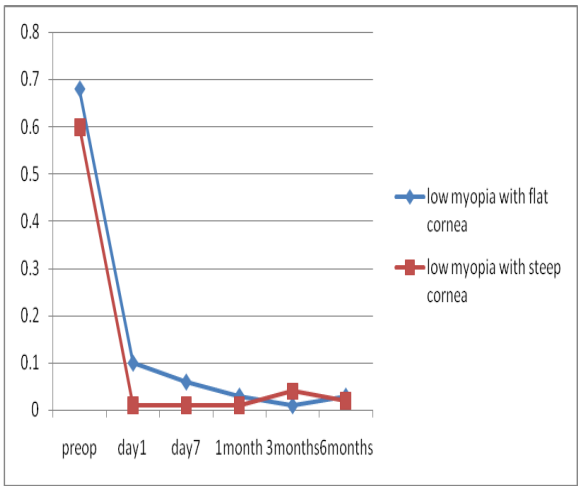

Figure IV. Changes in uncorrected visual acuity after LASIK surgery upto 6 months in low myopia

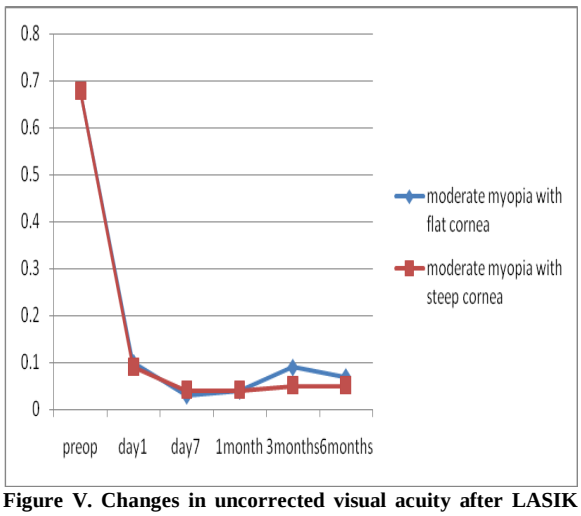

Figure V. Changes in uncorrected visual acuity after LASIK surgery upto 6 months in moderate myopia

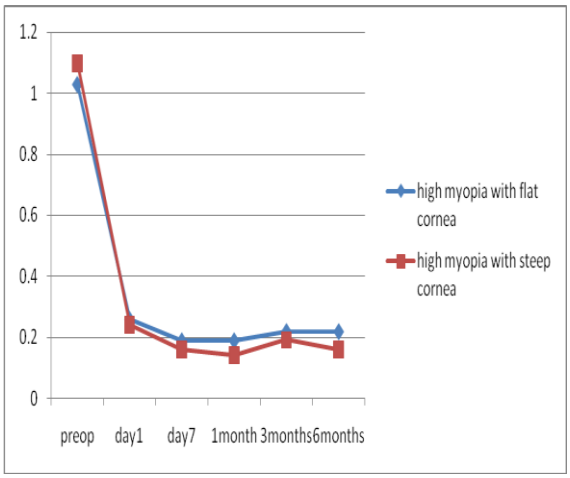

Figure VI. Changes in uncorrected visual acuity after LASIK surgery upto 6 months in high myopia

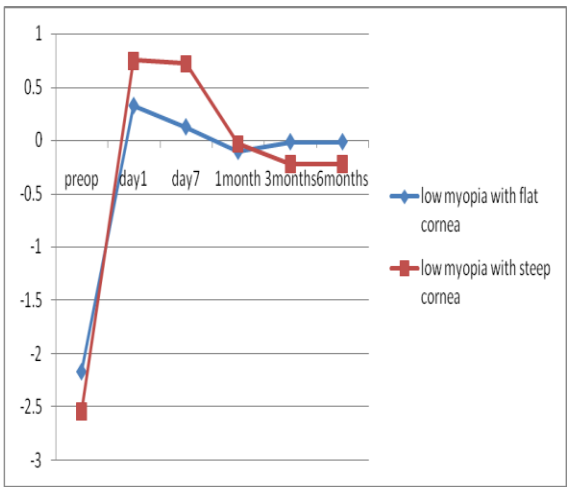

Figure VII. Changes in spherical equivalent after LASIK surgery upto 6 months in low myopia

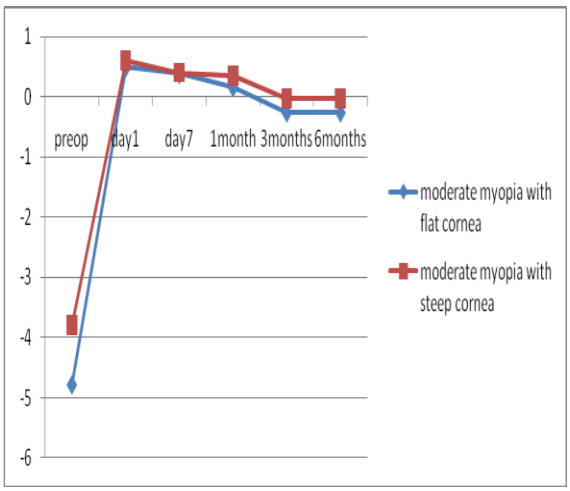

Figure VIII. Changes in spherical equivalent after LASIK surgery upto 6 months in moderate myopia

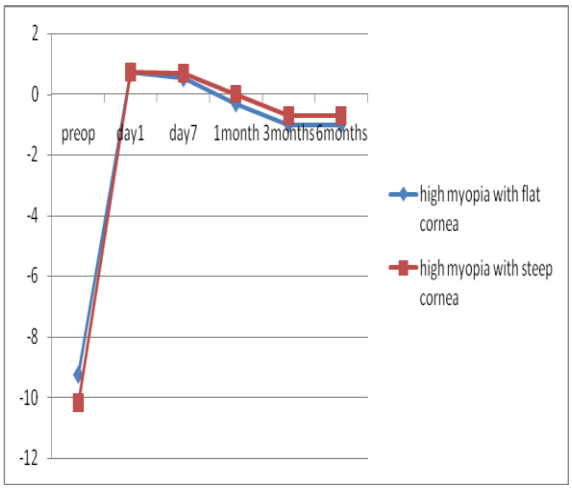

Figure IX. Changes in spherical equivalent after LASIK surgery upto 6 months in high myopia

In low myopia, between statistically matched preoperative groups of flat and steep cornea better visual outcomes were seen in steep group and at the same time more under correction were also noticed. In moderate and high myopia, between statistically matched preoperative groups of flat and steep cornea better visual outcomes were also seen in steep group, which compliments other observation that more under correction were seen in flat groups. Greater residual myopia was seen in patients with high myopia. Significant under correction noted in moderate and high myopia with flatter corneas but more significantly in high myopia.

DISCUSSION

To our knowledge, this is the first study to analyze visual outcomes in low, moderate and high myopia between subgroups of flat and steep preoperative keratometry. These flat and steep subgroups were matched preoperatively by age, preoperative spherical equivalent (SE). All surgeries were performed using ZEISS MEL80 machine. Our results suggest that eyes with steeper corneas have better visual outcomes than those with flatter corneas in all groups. However significant difference was noted in high myopia.

The clinical relevance of our study is best understood through comparison with the previous studies that examined eyes with moderate and high myopia. In our study we have compared visual outcomes in all three groups with low, moderate and high myopia, which showed better outcomes with steeper corneas. The relative change in corneal curvature produced by the ablation is responsible for correcting the myopia. It is therefore possible that more ablation will be required to produce a similar amount of effective change in a flatter cornea than a steeper cornea. One study by Christenson *et al*, with moderate myopia of -2.00 to -5.99 D, showed better outcomes with flatter corneas. [6] Rao*et al* evaluated eyes with high myopia of -6.0 to -13.9 D and followed them up for 3 months but they showed trend towards undercorrection for flatter corneas and better visual acuity with steeper corneas. [3] Perez-Santonja *et al* also reported a tendency towards undercorrection in eyes with flatter corneas that had LASIK for -8.00 to -20.00 D of myopia. [7] In our study sample size was greater than above two studies.

Refractive error has been corrected by two main procedures PRK and LASIK since many years now. In PRK flattening of corneal surface is been done by removal of superficial tissue while in LASIK stromal tissue is been ablated after making corneal flap. Mechanical and chemical factors of wound healing are different in these two techniques. The possibility of undercorrection after treating flatter corneas with a standard protocol has been described in a clinical data set of patients who had LASIK. [7,8] Other studies of patients treated with PRK have rejected this hypothesis. [9,10] These results should be cautiously applied to LASIK because the flap created causes changes in the cornea, which are not there in surface ablation techniques. The flap created can vary in size depending on preoperative keratometry and itself induce astigmatism and hyperopia, depending on hinge position and depth of stromal involvement. The stromal healing response and epithelial remodeling are less vigorous in LASIK. [9] Thus, surgical alterations in the cornea after LASIK are altered less by the healing response and any relationship between preoperative keratometry and final refraction may be more evident. We have done study of 170 eyes, LASIK performed by single surgeon, using standardized treatment protocol for all patients to reduce influencing factors as less as possible.

More studies should be performed to better define the effect that keratometry has on LASIK outcomes at varying levels of preoperative refraction. We can also consider to have more aggressive laser ablation in eyes with flatter corneas < 43.00 D, as to avoid undercorrection seen in our study. We suggest that preoperative K value should be kept in mind while calculating postoperative outcomes in LASIK patients along with other variants.

CONCLUSION

Eyes with steeper corneas showed better visual outcomes in all three groups, though undercorrection was observed in steep subgroup of low myopia.

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How to cite this article: Sethia RV, Patel EM, Anuja K. Desai et. al. Preoperative keratometry affecting visual outcome in myopic LASIK. Int J Health Sci Res. 2015; 5(8):109-115.

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