

# Correlation Factors for Posterior Corneal Curvature after Myopic LASIK

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## ABSTRACT

**Objective:** To evaluate the correlation factors for the posterior corneal curvature after myopic LASIK.

**Methods:** The retrospective study of 92 eyes which underwent myopic LASIK was conducted. All LASIK procedures were done using Hansatome® Microkeratome and Technolas® 217 excimer laser (B&L, USA). Pre- and post-operative data were collected including refraction, corneal thickness, anterior and posterior corneal curvature measured by Orbscan® Corneal Topography. Statistical analysis was done to evaluate the posterior corneal curvature related to other factors.

**Results:** The posterior corneal curvature after myopic LASIK showed no correlation to anterior corneal curvature ( $R^2 = 0.0036$ ). It also showed low to moderate correlation to amount of myopia treated ( $R^2 = 0.286$ ) and corneal thickness ( $R^2 = 0.37$  for measured corneal thickness and  $R^2 = 0.40$  for calculated corneal thickness which is calculated by subtract ablation depth from pre-operative thickness) (all  $p$  value  $< 0.05$ ).

**Conclusion:** The posterior corneal curvature after myopic LASIK can be partially correlated with corneal thickness, anterior corneal curvature and amount of myopia treated.

**Keywords:** Posterior Corneal Curvature, LASIK

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**T**he main objective of laser refractive surgery is to improve refractive state of human eye. By using excimer laser to remove specific part and amount of corneal tissue, the curvature of the cornea can be controlled. Therefore, some corneal tissue must be sacrificed to achieve this effect, resulting in thinner cornea. It has been well recognized about the biomechanical changes of the cornea after laser refractive procedure due to thin cornea.<sup>1</sup> Several articles have shown the changes especially in posterior corneal curvature post LASIK.<sup>2,3,4</sup> These changes effect the measurement of total corneal power by simple keratometer. The system measures only anterior corneal surface and assume the fixed anterior-posterior corneal relationship by using keratometric refractive index of 1.3375. It will calculate estimated posterior corneal curvature depend on the anterior corneal curvature. The study in normal myopic population has shown the range of total corneal power between 39 - 47 diopters.<sup>5</sup> It produces approximately posterior corneal power of -4.40 to -5.3 diopters by using

keratometric index calculation. After myopic LASIK procedure, the anterior-posterior corneal relationship has changed. The anterior surface was flattening by the laser. Contrary, the posterior surface was steeping by biomechanical effect.<sup>6,7</sup> Therefore, the use of keratometric refractive index is no longer valid. Simple keratometer which still using keratometric refractive index will produce the error of measurement post myopic LASIK particularly in the posterior cornea. This study was conducted to find any factors that might correlate to the posterior corneal curvature after myopic LASIK.

## MATERIALS AND METHODS

A retrospective study of 92 myopic eyes in 50 patients was conducted. All eyes had successful LASIK surgery at Department of Ophthalmology, Siriraj Hospital with at least 3 months follow up. All LASIK surgeries were performed by using Hansatome® Microkeratome and Technolas® 217 Excimer Laser (B&L, USA). Pre- and post-operative data was recorded including manifest refraction (sphere, cylinder and axis), and Orbscan® Corneal Topography (B&L, USA) for measured corneal thickness

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**TABLE 1.** Shows mean  $\pm$  SD of pre/post-operative manifest refraction, AC, PC, mCT and cCT (post-op)

	Pre-operative	Post-operative
Refraction (spherical equivalent) (D)	$-5.81 \pm 2.81$	$-0.23 \pm 0.70$
Anterior Corneal Curvature (D)	$43.94 \pm 1.15$	$39.73 \pm 1.96$
Posterior Corneal Curvature (D)	$-6.63 \pm 0.27$	$-6.15 \pm 0.41$
Measured Corneal Thickness ( $\mu\text{m}$ )	$562.05 \pm 28.83$	$479.11 \pm 39.03$
Calculated Corneal Thickness ( $\mu\text{m}$ )	-	$447.02 \pm 57.15$

(mCT), anterior corneal curvature (AC) and posterior corneal curvature (PC). The calculated corneal thickness (cCT) is calculated by subtract ablation depth from pre-operative corneal thickness. Statistic calculation (regression analysis) was done using SPSS for windows version 11.0 to correlate posterior corneal curvature to any other factors post-operatively.

## RESULTS

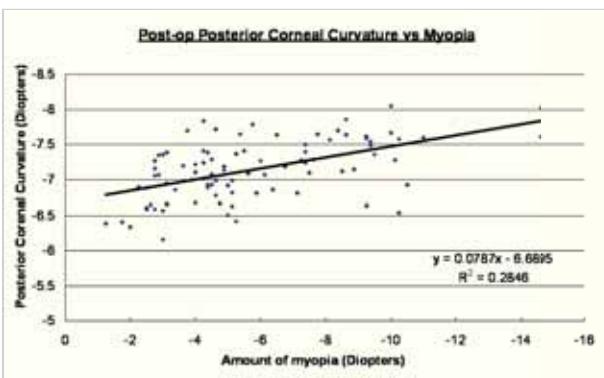
The mean age of the patients was  $30 \pm 7.2$  years old (range from 16 to 50 years old). The pre- and post-operative manifest refraction, AC, PC, mCT and cCT (post-op) were shown in Table 1.

With regression analysis, the post-operative PC showed no correlation to post-operative AC ( $R^2 = 0.0036$ ) (Fig 1). It showed low to moderate correlation to amount of myopia treated (AM) ( $R^2 = 0.28$ ) ( $y = 0.0792x - 6.689$ ) (Fig 2) and mCT ( $R^2 = 0.37$ ) ( $y = 0.0066x - 10.296$ ) (Fig 3). The cCT was shown to achieve slightly better correlation with the post-operative PC ( $R^2 = 0.40$ ) ( $y = 0.0047x - 9.2428$ ) (Fig 3). All  $p$  values were  $< 0.05$ .

## DISCUSSION

The corneal curvature after refractive surgery is one of the most interesting issues for refractive surgeons. It has been well aware that the measurement of corneal curvature with simple device after refractive surgery is not accurate.<sup>8</sup> This inaccuracy originates from the change of anterior-posterior corneal surface relationship as mentioned earlier. It will effect any calculation that uses the corneal curvature as a parameter. Among them, the intra-ocular lens calculation is the most interesting topic. Several studies have shown the error of the intra-ocular lens power calculation after refractive surgery.<sup>9,10,11</sup> Some authors proposed the new method of correcting this error.<sup>12,13,14</sup> Some authors use a special instrument to measure the true corneal power.<sup>15,16,17</sup>

The change of anterior-posterior corneal surface



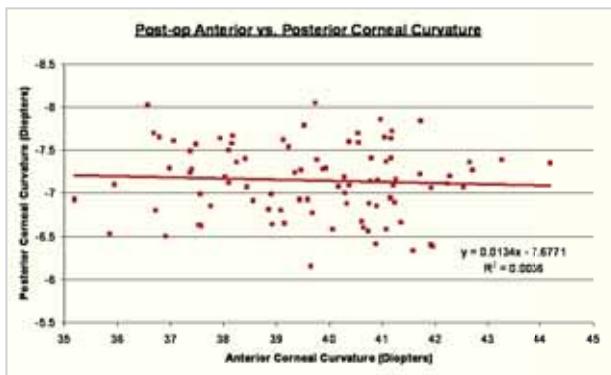
**Fig 2.** Shows the correlation between post-operative PC vs. AM

relationships can be partly measured with simple keratometer or placido disc topography. These simple devices directly measure the radius of anterior corneal curvature and then convert in to total corneal power by estimated posterior corneal curvature using keratometric index (1.3375).

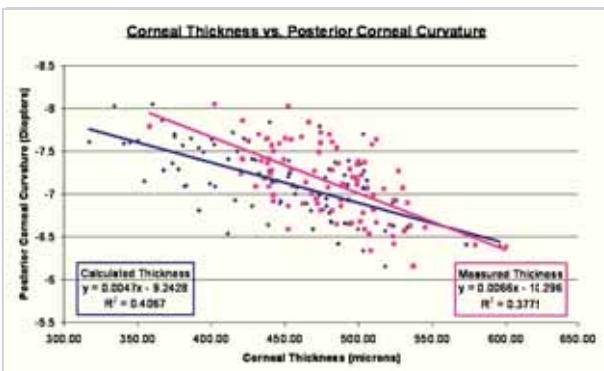
Our study was analyzed to find any factors that might correlate with posterior corneal curvature better than the estimation after myopic LASIK. Based on the biomechanical theory, the corneal thickness and amount of myopia treated are the interesting factors.

Previous study was shown the clinical benefit of Orbscan Corneal Topography in measuring posterior corneal curvature.<sup>18</sup> We used the Orbscan Corneal Topography to analyze the cornea in this study. This device is the placido disc system, which represents simple keratometer, combine with the multiple slit scanning system, which can directly measures the posterior corneal surface. The anterior corneal curvature is generated only from the placido image. Contrary, the corneal thickness and the posterior corneal curvature is generated from the slit scanning image.

Our study showed low to moderate correlation between posterior corneal curvature and other test factors (amount of myopia treated, corneal thickness) but not anterior corneal curvature. Interestingly, the post-operative measured corneal thickness (mCT) showed less correlation than calculated corneal thickness (cCT). This finding could be explained by epithelial hyperplasia<sup>19,20</sup> and mechanical elastic factor of the cornea.<sup>21</sup> It has been well known that the corneal stroma, not epithelium, has major role in elastic response of the cornea. The central epithelium will become thicken after myopic laser refractive surgery. For these reasons, the residual corneal stroma is the main concern to LASIK surgeons regarding corneal integrity. The mCT is include the thicken epithelium in account to the whole corneal



**Fig 1.** Shows the correlation between post-operative PC vs. AC



**Fig 3.** Shows the correlation between post-operative PC vs. cCT and mCT

thickness. Contrary, the cCT use pre-operative corneal thickness (no epithelium hyperplasia) and subtract by ablation depth. Therefore, the cCT will reflect the true elasticity of the cornea more than the mCT. But the pre-operative information is required for the calculation of the cCT. The mCT can be used to replace the cCT, but with lower correlation (0.37 compare to 0.40).

Further investigation is currently being conducted to refine the result. If the stronger correlation can be obtained by adding combination of several factors, there may be the way to predict the post-operative PC and adjust for total corneal power for the IOL calculation after myopic LASIK.

## REFERENCES

1. Dupp WJ Jr, Roberts C. Effect of acute biomechanical changes on corneal curvature after photokeratectomy. *J Refract Surg* 2001; 17: 658-69.
2. Twa MD, Roberts C, Mahmoud AM, Chang JS Jr. Response of the posterior corneal surface to laser in situ keratomileusis for myopia. *J Cataract Refract Surg* 2005; 31: 61-71.
3. Hernandez-Quintela E, Samapunphong S, Khan BF, Gonzalez B, Lu PC, Farah SG, Azar DT. Posterior corneal surface changes after refractive surgery. *Ophthalmology* 2001; 108: 1415-22.
4. Seitz B, Torres F, Langenbucher A, Behrens A, Suarez E. Posterior corneal curvature changes after myopic laser in situ keratomileusis. *Ophthalmology* 2001; 108: 666-72.
5. S. Srivannaboon, S Chotikavanich. Corneal Characteristics in myopic patients. *J Med Assoc Thai* 2005; 88: 1222-7
6. Hernandez-Quintela E, Samapunphong S, Khan BF, Gonzalez B, Lu PC, Farah SG, Azar DT. Posterior corneal surface changes after refractive surgery. *Ophthalmology* 2001; 108: 1415-22.
7. Seitz B, Torres F, Langenbucher A, Behrens A, Suarez E. Posterior corneal curvature changes after myopic laser in situ keratomileusis. *Ophthalmology* 2001; 108: 666-72.
8. Sonego-Krone S, Lopez-Moreno G, Beaujon-Balbi OV, Arce CG, Schor P, Campos M. A direct method to measure the power of the central cornea after myopic laser in situ keratomileusis. *Arch Ophthalmol* 2004; 122: 159-66.
9. Latkany RA, Chokshi AR, Speaker MG, Abramson J, Soloway BD, Yu G. Intraocular lens calculations after refractive surgery. *J Cataract Refract Surg* 2005; 31: 562-70.
10. Adrean SD, Reilly C, Mannis MJ. Intraocular lens calculation in a patient with previous penetrating keratoplasty and LASIK. *Cornea* 2005; 24: 629-31.
11. Wang L, Booth MA, Koch DD. Comparison of intraocular lens power calculation methods in eyes that have undergone LASIK. *Ophthalmology* 2004; 111: 1825-31.
12. Latkany RA, Chokshi AR, Speaker MG, Abramson J, Soloway BD, Yu G. Intraocular lens calculations after refractive surgery. *J Cataract Refract Surg* 2005; 31: 562-70.
13. Feiz V, Moshirfar M, Mannis MJ, Reilly CD, Garcia-Ferrer F, Caspar JJ, Lim MC. Nomogram-based intraocular lens power adjustment after myopic photorefractive keratectomy and LASIK: a new approach. *Ophthalmology* 2005; 112: 1381-7.
14. Rosa N, Capasso L, Lanza M, Iaccarino G, Romano A. Reliability of a new correcting factor in calculating intraocular lens power after refractive corneal surgery. *J Cataract Refract Surg* 2005; 31: 1020-4.
15. Sonego-Krone S, Lopez-Moreno G, Beaujon-Balbi OV, Arce CG, Schor P, Campos M. A direct method to measure the power of the central cornea after myopic laser in situ keratomileusis. *Arch Ophthalmol* 2004; 122: 159-66.
16. Srivannaboon S, Reinstein DZ, Sutton HF, Holland SP. Accuracy of orbscan total optical power maps in detecting refractive change after myopic laser in situ keratomileusis. *J Cataract Refract Surg* 1999; 25: 1596-9.
17. Langenbucher A, Torres F, Behrens A, Suarez E, Haigis W, Seitz B. Consideration of the posterior corneal curvature for assessment of corneal power after myopic LASIK. *Acta Ophthalmol Scand* 2004; 82: 264-9.
18. Leyland M. Validation of Orbscan II posterior corneal curvature measurement for intraocular lens power calculation. *Eye* 2004; 18: 357-60.
19. Flanagan GW, Binder PS. The theoretical vs. measured laser resection for laser in situ keratomileusis. *J Refract Surg* 2005; 21: 18-27.
20. Kramer TR, Chuckpaiwong V, Dawson DG, L'Hernault N, Grossniklaus HE, Edelhauser HF. Pathologic findings in postmortem corneas after successful laser in situ keratomileusis. *Cornea* 2005; 24: 92-102.
21. Ou RJ, Shaw EL, Glasgow BJ. Keratectasia after laser in situ keratomileusis (LASIK): evaluation of the calculated residual stromal bed thickness. *Am J Ophthalmol* 2002; 134: 771-3.