

# Photorefractive Keratectomy as A Retreatment of Residual Myopia after Previous Laser in Situ Keratomileusis

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## Abstract

**Purpose:** This study was planned to evaluate the efficacy, safety and complication of photorefractive keratectomy (PRK) as a retreatment of residual myopia after previous laser in situ keratomileusis (LASIK).

**Methods:** In this descriptive study in ophthalmology ward, Feiz Hospital, Isfahan University of Medical Sciences, Iran, with the consideration of inclusion and exclusion criteria, 170 eyes of the 92 patients were selected and underwent PRK with mitomycin C. One hundred-twenty seven eyes were in the first group (myopia ≤ -2 diopter [D]) and 43 eyes were in the second group (myopia > -2 D).

**Results:** This study was performed on 170 eyes of 92 patients with an average age of 35 years old (56 women and 36 men). The average interval between procedures was 17.5 ± 3.2 months. After 1 year, 94.7% of the eyes had uncorrected visual acuity (UCVA) (<sup>20</sup>/<sub>40</sub> or better) and 65.8% of eyes had UCVA (<sup>20</sup>/<sub>20</sub> or better). 135 eyes (79.4%) were within ±0.5 D and 168 eyes (98.8%) were within ±1.00 D of target refraction. Two eyes lost one line of best corrected visual acuity (BCVA) and 14 eyes had BCVA gain. In this study 20 eyes presented with corneal haze after one year after PRK (11.8%). Five eyes (3.9%) in first group (myopia ≤ -2.0 D) developed corneal opacity from the patients in second group (myopia > -2.0 D) 15 cases (34.9%) encountered corneal opacity. Before and after PRK, spherical equivalents of eyes were -1.84 ± 0.6 and -0.15 ± 0.2 D respectively (P < 0.001), mean UCVA was 0.34 ± 0.23 and 0.92 ± 0.14 of lines (P < 0.001), mean BCVA was 0.94 ± 0.4 and 0.98 ± 0.5 of lines (P = 0.84) and the mean corneal thickness was 428 ± 20 and 407 ± 12 microns respectively (P = 0.032).

**Conclusion:** PRK is an effective and safe procedure as a retreatment of post LASIK residual myopia. The treatment of higher grade of residual myopia has higher rate of postoperative complication.

**Keywords:** Photorefractive Keratectomy, Laser in Situ Keratomileusis, Retreatment

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## Introduction

Refractive errors are among the most prevalent problems in ophthalmology. Nowadays, treating these problems by surgery is widely used for attaining a perfect and high quality visual acuity (VA) in near and long distances without using eyeglasses and contact lenses. One of the most applicable methods for correcting of refractive errors is laser in situ keratomileusis (LASIK) surgery which is used for wide range of refractive errors such as mild to high myopia, hyperopia, and astigmatism.<sup>1-3</sup> In this method, a lamellar cut is made in cornea by a microkeratome and the obtained flap is raised and the underneath stroma receives laser energy. Changing the curvature of the central part of cornea, laser changes eye's refractive power and modifies it.<sup>4</sup> However, LASIK is a safe and effective surgery; like any other surgeries, it has some complications.<sup>1-5</sup> One of the most common complications is persistence of refractive error due to excess or scarcity of modification.<sup>6</sup> After the first one it's reported that the prevalence of retreatment surgery is increasing from 5% to 28% in several studies.<sup>7-9</sup>

Different methods are available for the retreatment after the LASIK surgery. Some of these methods lift the previous flap and directing the laser ray. Other methods include making a new flap, implementing a new photorefractive keratectomy (PRK), or laser sub-epithelial keratectomy (LASEK) on the previous flap. The two recent methods are applicable for the cases in which there is hesitation and solicitude about the remaining corneal thickness. The aim of this study was to investigate the effects, safety, and complications of PRK for treatment of residual myopia after LASIK surgery.

## Methods

This prospective clinical trial study has been performed on 170 eyes of 92 patients. The study inclusion criteria comprised patients' dissatisfaction with uncorrected visual acuity (UCVA) and his/her request for further surgery, passing at least 12 months from the preceding surgery, stability of refraction which was defined as the change in refraction lower than 0.5 diopter (D) in spherical equivalent during last 6 months, spherical equivalent refraction at least -0.75 D, UCVA lower than

or equal to  $20/30$ , estimating the existence of 250 micron corneal thickness at least after the second surgery and absence of flap complication from previous Lasik (including free cap, incomplete flap, macrostriae, and so on).

Patients with topographic changes suspicious to keratoconus or ectasia and irregular astigmatism were excluded from the study. Among the patients who requested a second surgery due to dissatisfaction with the first operation, 34 persons were excluded for lack of other study inclusion criteria. Consent for the surgery was taken from the patients after giving explanations on surgery, complications such as residual refractive error, regression, haze formation, infection and other treatment options such as spectacle or contact lenses available. Before the surgery, a complete physical examination was done on patients' eyes. This examination included refraction (manifest and cycloplegic), measuring the degree of UCVA and best corrected visual acuity (BCVA), slit-lamp biomicroscopy, Goldmann tonometry, fundus examination after pupil dilation, orbiscan corneal topography, and pachymetry. The minimum interval between surgeries was twelve months and its average was  $17.5 \pm 3.2$  months.

In order to perform PRK, the eye was anesthetized by tetracaine 0.5% and an eyelid speculum was placed in it. The optic zone was set to be between 6 to 7 millimeters. Using 20% alcohol for 15 seconds the epithelium was removed and technolas 217 excimer laser (Bausch & Lomb Technolas) was used for corneal ablation. The ablation was performed in standard fashion to correct the spherocylindrical error only. Then mitomycin 0.02% was used for 1 minute and 20 seconds (80 second) on stroma and after that it was irrigated using 50 cc sodium chloride irrigation serum. Immediately after finishing surgery, a bandage contact lens was placed on cornea and ciprofloxacin and betamethason eye drops were prescribed for the patient. Patients were visited on first, third, and seventh days, fourth week, and third, sixth, and twelfth month. At the first day visit, patients were examined regarding the position of contact lens and infection. On third and seventh day, they were visited considering the

epithelium healing and removing the contact lens (on seventh day). In subsequent visits, they were examined concerning corneal opacity (haze) and its treatment. After a year, the patients were visited for measuring UCVA, BCVA, final refraction and determining satisfaction of patients with the result of surgery (using a specified questionnaire that include the questions about the distant and near vision without spectacles or contact lenses, reading in night time, halo, glare, monocular diplopia, foreign body sensation, improvement in performance of routine daily activity) and the findings were recorded. Corneal opacity (haze) was measured and graded as follows: Grade 0: clear; Grade 0.5: very low opacity which is only visible in tangential illumination; Grade 1: opacity with minimum density which is hardly visible and viewed by direct illumination; Grade 2: medium opacity simply visible using direct illumination; Grade 3: remarkable (significant) opacity which slightly obscures seeing anterior chamber and iris details; Grade 4: remarkable (significant) opacity which vastly obscures seeing anterior chamber and iris details. For analysis and comparison, patients were divided into two groups based on the severity of myopia before PRK surgery. The first group included patients with myopia lower than or equal to 2 D and the second included patients with myopia higher than 2 D.

Paired t-test, T student,  $\chi^2$  tests were used for statistical analysis. The  $\chi^2$  test was used to compare qualified data and Paired t-test and T student test were used to compare quantified data. The fisher exact test also used to compare the frequency distribution. Data is mostly presented as mean $\pm$ standard deviation and  $P < 0.05$  is considered as significant. Statistical analysis is performed by SPSS software version 17.

## Results

This study was performed on 170 eyes of 92 patients of which 56 (57.1%) patients were females and 36 (42.9%) were males. The average of patients' age was  $31.7 \pm 7.3$  in males and  $32.8 \pm 7.6$  in females and there is no significant statistical differences between the two groups with T student test ( $P = 0.33$ ). The average of spherical equivalent refractive error of patients before LASIK operation was  $-6.25 \pm 2.2$  D and it was  $-1.84 \pm 0.6$  D before

PRK (the range was  $-0.75$  to  $-3.25$ ). The minimum interval between surgeries was twelve months and its average was  $17.5 \pm 3.2$  months. Based on the severity of myopia before PRK operation, patients were divided into two groups. First group included patients with myopia equal to or lower than  $-2$  D and second group included the patients with myopia higher than  $-2$  D. 127 (74.7%) eyes were placed in first group and 43 (25.3%) eyes in second group. The results of examinations before PRK operation are showed in table 1. The average of ablated corneal tissue in previous LASIK was  $75 \pm 16$  micron and in PRK surgery it was  $28 \pm 11$  micron. Epithelial healing in all patients was complete after a week. The VA results, one year after PRK is illustrated in table 2. The Fisher exact test revealed that there was significant statistical differences in frequency distributions of UCVA between these two groups ( $P < 0.001$ ). This test also showed that these frequency distributions of UCVA have no statistical significant difference between males and females ( $P = 0.23$ ).

One hundred and ten eyes in the first group (86.6%) and 25 eyes in the second group (58.1%) were in the range of  $\pm 0.5$  D refraction. All eyes in the first group and 41 cases in the second group (95.3%) were located in the range of  $\pm 1$  D of refractive error. Two eyes in the second group had refraction over  $-1$  D. Two eyes in the second group had a decrease of 1 line of Snellen's chart in their BCVA. In 14 eyes the BCVA improved 1 to 2 lines.  $\chi^2$  test revealed that there was no significant difference of refractive error in two sexes ( $P = 0.36$ ).

In this study 20 eyes presented corneal haze after one year of PRK (11.8%). Five eyes (3.9%) in the first group (myopia  $\leq -2.0$  D) developed corneal opacity of grade 1 during the follow-up and they were treated with repeated topical steroid. In the second group (myopia  $> -2.0$  D) 15 cases (34.9%) presented corneal opacity, 1 case of grade 3, 6 cases of grade 2, and the remaining had grade 1 opacity. At the end of the year, corneal opacity remained constant in 7 eyes, in 4 cases were classified as grade 2, 3 were in grade 1. The  $\chi^2$  test revealed that the rate of corneal opacity is greater in the second group (myopia  $> -2.0$  D) ( $P = 0.001$ ); this test also showed that there were no significant

differences in the rate of corneal haze between male and female (9.6% versus 13.4%, respectively) ( $P=0.45$ ). The fisher exact test revealed that there is no significant difference between the improvement of corneal haze and the change in refractive error ( $P=0.15$ ) in two sexes.

No case of corneal Ectasia was observed in this study. The UCVA, BCVA, spherical

equivalent and corneal thickness of patients before and after PRK are compared in table 3.

After the first year, 54 patients (58.6%) were absolutely satisfied with the result of the surgery and 31 cases (33.6%) were moderately satisfied and in 87 cases (94.5%), there was a better vision and less annoying signs such as halo around the light was reduced.

**Table 1.** The results of patient examination before photorefractive keratectomy of two groups

|                         | Uncorrected visual acuity (Decimal notation) | Best corrected visual acuity (Decimal notation) | Average spherical equivalent (D) | Average cylindrical power (D) | Average spherical error (D) | Corneal thickness (micromete r) |
|-------------------------|--|---|----------------------------------|-------------------------------|-----------------------------|---------------------------------|
| Myopia group $\leq$ -2D | 0.41 $\pm$ 0.18                              | 0.96 $\pm$ 0.3                                  | -1.68 $\pm$ 0.5                  | -0.72 $\pm$ 0.4               | -2.42 $\pm$ 0.4             | 434 $\pm$ 12                    |
| Myopia group $>$ 2D     | 0.18 $\pm$ 0.28                              | 0.90 $\pm$ 0.52                                 | -2.64 $\pm$ 0.3                  | -1.12 $\pm$ 0.7               | -4.0 $\pm$ 0.3              | 410 $\pm$ 16                    |
| All patients            | 0.34 $\pm$ 0.23                              | 0.94 $\pm$ 0.4                                  | -1.84 $\pm$ 0.6                  | -0.87 $\pm$ 0.3               | -1.72 $\pm$ 0.7             | 428 $\pm$ 20                    |

D: Diopter

**Table 2.** The visual acuity of two groups one year after photorefractive keratectomy

|   | Group with myopia $\leq$ -2 D |         | Group with myopia $>$ -2 D |         |
|---|-------------------------------|---------|----------------------------|---------|
|   | number                        | Percent | number                     | Percent |
| UCVA $>$ 20/40 (Less than $^{20}/_{20}$ ) | 22                            | 17.4%   | 36                         | 83.7%   |
| UCVA= $^{20}/_{20}$                       | 105                           | 82.6%   | 7                          | 16.3%   |
| Total                                     | 127                           | 100%    | 43                         | 100%    |

UCVA: Uncorrected visual acuity  
D: Diopter

**Table 3.** Comparison of uncorrected visual acuity, best corrected visual acuity, spherical equivalent and corneal thickness before and after photorefractive keratectomy

|            | UCVA (Decimal)  | BCVA (Decimal) | Spherical equivalent (D) | Optical pachymetry (Micron) |
|------------|-----------------|----------------|--------------------------|-----------------------------|
| Before PRK | 0.34 $\pm$ 0.23 | 0.94 $\pm$ 0.4 | -1.84 $\pm$ 0.6          | 428 $\pm$ 20                |
| After PRK  | 0.92 $\pm$ 0.5  | 0.98 $\pm$ 0.5 | -0.15 $\pm$ 0.2          | 407 $\pm$ 12                |
| P          | $<$ 0.001       | 0.84           | $<$ 0.001                | 0.032                       |

PRK: Photorefractive keratectomy  
UCVA: Uncorrected visual acuity  
BCVA: Best corrected visual acuity

## Discussion

One of the most common complications of LASIK is under or overcorrection and when the remaining refractive error causes problems for the patient, a retreatment may be considered. For this purpose, specially following the previous LASIK surgery, when the corneal thickness is extremely reduced. We may employ surface ablation method. The purpose of this study is evaluating the efficacy, safety, and side effects of PRK surgery as a retreatment modality to correct the residual myopia after LASIK surgery.

It is evident that the efficacy criteria for a refractive surgery is the number of eyes gaining maximum UCVA. In this investigation the initial average UCVA at presentation was  $0.34 \pm 0.23$  Snellen ( $0.45 \pm 0.6$  logMAR) which was improved to  $0.92 \pm 0.14$  ( $0.035 \pm 0.8$  logMAR) after surgery (Table 3) indicating that 65.8% of the cases had visions of  $20/20$  or better and 94.7% had vision of  $20/40$  or more. These amounts were reduced to 59.4% and 87% respectively by the end of third month. In most cases this reduction of vision was due to the corneal opacity and in some cases it was attributed to refraction stability. In a parallel study performed by Beerthuisen, 58% of the eyes had visions higher or equal to  $20/20$  and 92% had the minimum vision of  $20/40$  at the end of the first year.<sup>10</sup> In Netto et al's study in which retreatment by lifting the flap is applied, 58% of the patients had UCVA equal to or better than  $20/20$  and 92% had UCVA equal to or better than  $20/40$ .<sup>11</sup> In a study by Saeed et al, in which LASIK method was used for retreatment, 84% of cases had visions equal or better than  $20/30$ .<sup>12</sup> In this present investigation, two eyes in the second group (myopia > -2 D) had 1 line of reduction of BCVA after one year of the second intervention caused by the corneal haze. Other similar studies showed similar results.<sup>10-13</sup> In 14 eyes (8.2% of cases), BCVA increased which was due to the microstriae reduction of the flap caused by surface ablation. Therefore, removing Bowman's layer through surface ablation may be useful in microstriae treatment.<sup>10</sup> In our experience 135 eyes (79.4%) had the postoperative refractive error of  $\pm 0.5$  D. Two eyes had myopia of more than -1 D which was due to the corneal haze. These results are also attained in studies with other methods of treatment.<sup>14-15</sup> The most

important complication which occurred in our study was subepithelial corneal haze. The extent of this complication in patients with myopia higher than -2 D was higher and more severe. Most of the cases which were observed in grade 1 were corneal haze that improved after treatment and left no effect on patients' final vision. All cases of grade 2 and 3 of opacity, had primary refractions over -6 D. In fact the occurrence of corneal haze is one of the most important complications of. The theory that Carones presented for justifying this problem was existence of lamellar cut as the reason of corneal opacity. Lamellar cut resulted from previous LASIK leads to keratocyte apoptosis in corneal stroma and creating other keratocytes on two sides of microkeratome cut. Performing ablation by laser excimer in area in which there exists apoptotic keratocytes, provokes an intense healing response which develops a severe opacity.<sup>16-17</sup> In the other study, PRK performed 2 years after LASIK; Its authors hypothesized that LASIK-induced corneal nerve damage disturbing corneal wound healing by increasing the tendency for development of haze.<sup>18</sup> Nevertheless usage of better lasers and also prophylactic application of mitomycin C to suppress keratocytes, this complication is vastly decreased.<sup>10-13</sup> No case of opacity was observed in Srinivasan's study which was performed for investigating the prophylactic effect of mitomycin C in occurrence of corneal opacity in cases of PRK after LASIK.<sup>13</sup> Another point to be noted in the current study is that best results of surgery are observed in patients who are in the group of myopia lower than or equal to -2 D. More than 90% of patients with refractions over -2 D, had refractive error higher than -5.5 D before Lasik. For instance, just 16.3% of these patients had visions better than or equal to  $20/20$  by the end of the first year (compared to 82.6% of patients with myopia lower than or equal to -2 D) and 58.1% of them were in the refraction range of  $\pm 0.5$  D. In addition the possibility for complications and reduction of vision is higher in these patients. Studies conducted on patients with high myopia investigating retreatment methods also confirm partially successful results and the subsistence of threatening factors for patients' vision.<sup>18</sup> Therefore extra caution must be

exerted about these patients. One of the limitations of this study is that the corneal flap thickness measurement was not performed preoperatively, and also PRK is not compared to other retreatment methods.

### Conclusion

It seems that PRK surgery as a retreatment for residual post-LASIK myopia is an

advantageous and safe method with minor complications. But with regard to more frequent and complication in patients with higher refractive errors, it is recommended to pay special attention to these cases and to inform them about the consequences of this surgery. Further studies are needed to compare different techniques of treatment of residual refractive errors.

### References

- O'Doherty M, O'Keefe M, Kelleher C. Five year follow up of laser in situ keratomileusis for all levels of myopia. *Br J Ophthalmol* 2006;90(1):20-3.
- Güell JL, Muller A. Laser in situ keratomileusis (LASIK) for myopia from -7 to -18 diopters. *J Refract Surg* 1996;12(2):222-8.
- Esquenazi S, Mendoza A. Two-year follow-up of laser in situ keratomileusis for hyperopia. *J Refract Surg* 1999;15(6):648-52.
- Pallikaris IG, Papatzanaki ME, Stathi EZ, et al. Laser in situ keratomileusis. *Lasers Surg Med* 1990;10(5):463-8.
- Gimbel HV, Penno EE, van Westenbrugge JA, et al. Incidence and management of intraoperative and early postoperative complications in 1000 consecutive laser in situ keratomileusis cases. *Ophthalmology* 1998;105(10):1839-47.
- Ambrósio R Jr, Wilson SE. Complications of laser in situ keratomileusis: etiology, prevention, and treatment. *J Refract Surg* 2001;17(3):350-79.
- Hersh PS, Fry KL, Bishop DS. Incidence and associations of retreatment after LASIK. *Ophthalmology* 2003;110(4):748-54.
- Lyle WA, Jin GJ. Retreatment after initial laser in situ keratomileusis. *J Cataract Refract Surg* 2000;26(5):650-9.
- Ozdamar A, Aras C, Bahçecioglu H, Sener B. Secondary, laser in situ keratomileusis, 1 year after primary LASIK for high myopia. *J Cataract Refract Surg* 1999;25(3):383-8.
- Beerthuisen JJ, Siebelt E. Surface ablation after laser in situ keratomileusis: retreatment on the flap. *J Cataract Refract Surg* 2007;33(8):1376-80.
- Netto MV, Wilson SE. Flap lift for LASIK retreatment in eyes with myopia. *Ophthalmology* 2004;111(7):1362-7.
- Saeed A, O'Doherty M, O'Doherty J, O'Keefe M. Analysis of the visual and refractive outcome following laser in situ keratomileusis (LASIK) retreatment over a four-year follow-up period. *Int Ophthalmol* 2007;27(1):23-9.
- Srinivasan S, Drake A, Herzig S. Photorefractive keratectomy with 0.02% mitomycin C for treatment of residual refractive errors after LASIK. *J Refract Surg* 2008;24(1):S64-7.
- Rashad KM. Laser in situ keratomileusis retreatment for residual myopia and astigmatism. *J Refract Surg* 2000;16(2):170-6.
- Carones F, Vigo L, Carones AV, Brancato R. Evaluation of photorefractive keratectomy retreatments after regressed myopic laser in situ keratomileusis. *Ophthalmology* 2001;108(10):1732-7.
- Mohan RR, Hutcheon AE, Choi R, et al. Apoptosis, necrosis, proliferation, and myofibroblast generation in the stroma following LASIK and PRK. *Exp Eye Res* 2003;76(1):71-87.
- Brahma A, McGhee CN, Craig JP, et al. Safety and predictability of laser in situ keratomileusis enhancement by flap reelevation in high myopia. *J Cataract Refract Surg* 2001;27(4):593-603.
- Neira-Zalentein W, Moilanen JA, Tuisku IS, et al. Photorefractive keratectomy retreatment after LASIK. *J Refract Surg* 2008;24(7):710-2.