ORIGINAL RESEARCH

# Excimer laser photorefractive keratectomy for myopia: Two years of follow-up

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*This paper was presented in part of the Hong Kong '96 Ocular Surgery News Symposium, March 22-23, 1996*

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## Abstract

**Aim:** To study the safety and efficacy of laser photorefractive keratectomy in different myopia groups.

**Materials and methods:** 51 eyes of 30 patients underwent photorefractive keratectomy (PRK) with a 193nm excimer laser to correct myopia. The eyes were divided into three groups: low, moderate, and high myopia.

**Results:** Two years after PRK, 100% of the eyes in the low myopia group, 86.7% in the moderate myopia group, and 28.6% in the high myopia group achieved an uncorrected visual acuity of 20/40 or better. In the low myopia group, 100% were within ±1 diopter (D) of emmetropia, as were 86.7% in the moderate group and 23.8% in the high myopia group. None of the eyes in the low myopia group, 13.3% in the moderate myopia group, and 57.1 % in the high myopia group regressed more than 1 D over the observation period. No significant complications were observed.

**Conclusion:** Photorefractive keratectomy can be considered as an effective and safe procedure for correcting myopia in the low and moderate range.

## Introduction

Excimer laser photorefractive keratectomy (PRK) has been used for the correction of myopia since 1983, when Trokel and coauthors[1] first used the excimer laser to ablate the cornea. Many studies have since been done to evaluate the clinical results of PRK. In this study, the authors report the results of PRK on 51 eyes of 30 patients over a followed up period of two years.

## Material and methods

Between October 1992 and November 1993, PRK was performed by the first author (PPCT) on 54 eyes of 33 patients at an out-patient eye center in Hong Kong. 30 patients were followed up for 2 years. Three patients, who defaulted follow-up, were excluded from the study. Our report was on 51 eyes (37 female) of 30 patients, ranging in age from 23 years to 45 years (mean 30.8 ± 5.5 years). There were 29 oriental patients and 1 Caucasian patient.

Only patients over 21 years old were included in this study. The spherical portion of their refractive error could not have changed more than 0.5 diopter (D) in the year preceding the baseline examination or more than 1.0 D during the preceding three years. Patients with recurrent or active ocular diseases, corneal abnormalities (e.g. keratoconus), systemic diseases or on medications (e.g. corticosteroids) likely to affect healing or immunity, were excluded.

Spherical equivalent refraction ranged from -1.50 D to -16.50 D (mean -7.34 ± 3.69 D) and refractive cylinder from 0 D to -4.50 D (mean -0.77 ±0.96 D). The eyes were divided into three groups according to their manifest refractive error (spherical equivalents): low myopia, -5.00 D and below (n = 15); moderate myopia, -5.25 D to -8.00 D (n = 15); and high myopia, -8.25 D and above (n = 21). Photoablations were performed with the 20/20 193nm excimer laser (VISX, Inc., Sunnyvale, CA) using a fluence of 160mJ/cm$^2$ and a frequency of 5Hz. Multizone treatment was done as follows: low myopia, 6.0mm ablation zone; moderate myopia, 5.0mm for 60% of correction, 6.0mm for 40%; high myopia, 4.5mm for 50%, 5.0mm for 30%, and 6.0mm for 20% of correction. Postoperatively, treated eyes were examined every 24 to 48 hours until full re-epithelialization.Fluorometholone (FML®), tobramycin and dexamethasone (TobraDex®) eyedrops were given in conjunction with eye patching or bandage contact lenses until re-epithelialization was complete. Thereafter, FML drops were given four times a day for the first and second week, three times a day for the third week, two times a day for the fourth week, and daily from the second to fourth month.

During each visit, vision (uncorrected and corrected) was recorded and manifest refraction was done. Slit lamp biomicroscopy was done to assess the degree of haze and occurrence of complications. At the 2-year follow-up visit, patients were questioned on their satisfaction on the surgical result of each eye.

## Results

Table 1 shows the refractive results for all groups. Some patients missed one or two follow-up visits, so the number of eyes varied by visit. The mean spherical equivalent of the high myopia group was significantly higher than those of the middle and high myopia group at all post-operative times (one way ANOVA). The difference between the mean spherical equivalents of the low and moderate myopia groups at any post-operative time was insignificant.

Table 2 shows the deviation from emmetropia. Two years post-operatively, the high myopia group had significantly lower number of eyes within the ±1.0 D range than the low myopia group (P = 0.000028) and the moderate myopia group (P = 0.00025). The difference between the number of eyes within ±1.0 D range in the low and moderate myopia group was not significant (Fisher Exact test)

The post-operative uncorrected visual acuities (VA) were compared among the three groups (Table 3). Two years post-operatively, the high myopia group had significantly less eyes reaching uncorrected VA of 20/40 or better than the low myopia group (P = 0.000009) and the moderate myopia group (P = 0.007). The difference between the number of eyes reaching VA of 20/40 or better in the low and moderate myopia group was not significant (Fisher Exact test). When changes in best corrected post-operative visual acuity of the three groups were compared, the number of eyes losing one or more Snellen lines of best-corrected VA showed no significant difference best-corrected VA showed no significant difference among the three groups at the end of two years (Table 4).

In terms of corneal clarity, at one month, nearly all patients showed trace to 1 subepithelial haze. At 2 years, in the low myopia group, all corneas were clear except one with a trace of haze. In the moderate myopia group, 1 cornea showed trace haze while 2 corneas showed 1 haze. In the high myopia group, 5 corneas showed trace haze while 2 corneas

**Table 1. Refractive results by group and time.**

| | | Low Myopia | | | Moderate myopia | | | High myopia | |
|---|---|---|---|---|---|---|---|---|---|
| Group/ Time | NO of eyes | Mean Spherical Equivalent (± SD) | Range | NO of eyes | Mean Spherical Equivalent (±SD) | Range | NO of eyes | Mean Spherical Equivalent (±SD) | Range |
| Pre-op | 15 | -3.32 ± 1.07 | -1.50 to -4.75 | 15 | -6.20 ± 0.68 | - 5.25 to -7.50 | 21 | -11.02 ±2.34 | -8.25 to -16.50 |
| 1 month | 15 | +0.05 ± 0.32 | +0.75 to -0.50 | 15 | -0.03 ± 0.51 | +0.75 to -0.75 | 21 | -0.79 ±0.99 | +0.75 to -3.00 |
| 6 months | 11 | 0 ± 0.37 | +0.50 to -0.50 | 13 | -0.27 ± 0.64 | +0.75 to -1.50 | 20 | -1.90 ± 1.40 | 0 to -4.50 |
| 1 year | 7 | -0.18 ± 0.37 | +0.50 to -0.50 | 9 | -0.69 ± 0.68 | +0.25 to -1.50 | 18 | -2.58 ±1.45 | -0.25 to -5.50 |
| 1-1/2 years | 7 | -0.32 ± 0.49 | +0.50 to -0.75 | 9 | -0.72 ± 0.82 | +0.25 to -2.25 | 17 | -2.91 ± 1.65 | -0.25 to -6.50 |
| 2 years | 15 | -0.27 ± 0.38 | -0.50 to -0.75 | 15 | -0.47 ± 0.83 | +0.75 to -2.50 | 21 | -2.36 ± 1.70 | 0 to -6.25 |

**Table 2. Deviation from intended correction. (emmetropia)**

| | | Deviation from Emmetropia, No. of eyes (%) | | | |
|---|---|---|---|---|---|
| Group /Time | Total Eyes | ± 0.5 D | ± 1.0 D | -1.1 to -2.0 D | ≥-2.1 D |
| Low myopia | | | | | |
| 1 month | 15 | 14 (93.30) | 15 (100) | - | - |
| 6 months | 11 | 11 (100) | 11 (100) | - | - |
| 1 year | 7 | 7 (100) | 7 (100) | - | - |
| 1-1/2 years | 7 | 4 (57.1) | 7 (100) | - | - |
| 2 years | 15 | 12 (80.0) | 15 (100) | - | - |
| Moderate myopia | | | | | |
| 1 month | 15 | 12 (80.0) | 15 (100) | - | - |
| 6 months | 13 | 8 (61.5) | 11 (84.6) | 2 (15.4) | - |
| 1 year | 9 | 5 (55.6) | 5 (55.6) | 4 (44.4) | - |
| 1-1/2 years | 9 | 5 (55.6) | 7 (77.8) | 2 (22.2) | - |
| 2 years | 15 | 11 (73.3) | 13 (86.7) | 1 (6.7) | 1 (6.7) |
| High myopia | | | | | |
| 1 month | 21 | 11 (52.4) | 16 (76.2) | 3 (14.2) | 2 (9.5) |
| 6 months | 20 | 3 (15.0) | 8 (40.0) | 3 (15.0) | 9 (4.5) |
| 1 year | 18 | 1 (5.6) | 3 (16.7) | 5 (27.8) | 10 (55.6) |
| 1-1/2 years | 17 | 1 (5.9) | 2 (11.8) | 5 (29.4) | 10 (58.9) |
| 2 years | 21 | 3 (14.3) | 5 (23.8) | 5 (23.8) | 11 (52.4) |

showed 1 haze. The difference in the frequency of 1 or more haze between groups was not significant (Table 5). There were no complications encountered both in the operative or post-operative period. There was no incidence of recurrent epithelial erosions, infection or steroid-induced glaucoma.

In terms of patient satisfaction at 2 years, overall 44 eyes (86.3%) were described as very satisfied or satisfied. There was no statistically significant difference in the level of satisfaction among groups (Table 6).

## Discussion

This study shows that excimer laser PRK is an effective means of reducing myopia, a fact well confirmed by a previous study in Hong Kong.[2] At 2 years, 35 eyes (66.6%) achieved uncorrected visual acuity of 20/40 or better. This level of efficacy is in line with other studies.[3-5] The level of efficacy was much higher in the low myopia group, where 15 eyes (100%) achieved uncorrected VA of 20/40 or better, in concordance with that reported by Kim.[6]

This study also shows that excimer laser PRK has reasonably good predictability, especially in low to moderate degrees of myopia where the percentages of eyes achieving ±1.0 D of emmetropia were 100% and 86.7% respectively. This high level of predictability in low to moderate myopia has also been shown in previous studies.[3,6-9] However, in the high myopia group, the results were less encouraging. The percentage of eyes achieving ±1.0 D of emmetropia was only 23.8%, significantly lower than the corresponding percentage in low and moderate myopia. This poor predictability in high myopia eyes has also been reported in other studies.[5,7,10,11] Gatry[7] explained that the poor predictability in high correction might be due to: (1) an error in the algorithm that would be cumulative with larger number of pulses; (2) poorer ablation rates at deeper levels of stroma.

With regard to the stability of achieved results, this study shows that all three myopia groups did show some changes of spherical equivalent refraction over the 2-year observation period. The mean myopic shift in the high myopia group was -1.57 D ±1.79 D and was significantly higher than those of the low myopia (-0.32 D ±0.38 D) and the moderate myopia groups (-0.43 D ±0.64 D). None of the eyes in the low myopia group and 13.3% of moderate myopia group regressed more than 1 D over the observation period, while 57.1% in the high myopia group regressed more than 1 D, indicating the instability of results in the latter group. The greater myopic regression with higher attempted corrections was also reflected in earlier research studies.[7,12,13] This might have been due to more marked tissue healing responses resulting from deeper ablations. The effect of topical steroids in reversing or alleviating regression has been well documented.[15-17] However, the view of some authors that refractive stabilization takes longer in high myopia than in low myopia cases was not confirmed by this study.[10,14]

Safety is defined as maintenance of corneal clarity, absence of complications and preservation of best corrected visual acuity. In this study, at 2 years post-operatively, overall only 4 eyes (8%) showed 1 haze, while others showed either no or trace haze. There was no statistically significant difference among the myopia groups in the intensity of haze. This is in line with the findings of Aron-Rosa although other authors found that eyes with higher attempted corrections were more likely to have higher hazescores.[15,18,19]There were no notable complications and no overcorrection by more than 1.0 D after 1 year, which was considered as a significant refractive complication.[13] The absence of severe haze and complications resulted in good preservation of best corrected visual acuity. At 2 years post-operatively, overall 47 eyes (92.2%) either showed no change in best corrected visual acuity or had gained one or more Snellen lines. This compares well with the figure in a previous study with 6

**Table 3. Uncorrected visual acuity**

| Uncorrected Visual Acuity, Number of eyes (%) | | | | | |
|---|---|---|---|---|---|
| Group / Time | Total Eyes | 20/12 to 20/20 | 20/25 to 20/40 | 20/50 to 20/100 | ≥20/200 |
| Low myopia | | | | | |
| 1 month | 15 | 2 (13.3) | 11 (73.3) | 2 (13.3) | - |
| 6 months | 11 | 0 ( 0 ) | 11 (100) | - | - |
| 1 year | 7 | 1 (14.3) | 6 (85.7) | - | - |
| 1-1/2 years | 7 | 0 ( 0 ) | 7 (100) | - | - |
| 2 years | 15 | 2 (13.3) | 13 (86.7) | - | - |
| Moderate myopia | | | | | |
| 1 month | 15 | 2 (13.3) | 9 (60.0) | 4 (26.7) | - |
| 6 months | 13 | 2 (15.4) | 11 (84.6) | - | - |
| 1 year | 9 | 0 ( 0 ) | 9 (100) | - | - |
| 1-1/ 2years | 9 | 0 ( 0 ) | 8 (88.9) | 1 (11.1) | - |
| 2 years | 15 | 0 ( 0 ) | 13 (86.7) | 2 (13.3) | - |
| Hing myopia | | | | | |
| 1 month | 21 | 0 ( 0 ) | 7 (33.3) | 14 (66.7) | - |
| 6 months | 20 | 0 ( 0 ) | 8 (40.0) | 12 (60.0) | - |
| 1 year | 18 | 0 ( 0 ) | 5 (27.8) | 10 (55.6) | 3 (16.7) |
| 1-1/2 years | 17 | 0 ( 0 ) | 4 (23.5) | 10 (58.8) | 3 (17.6) |
| 2 years | 21 | 0 ( 0 ) | 6 (28.6) | 10 (47.6) | 5 (23.8) |

months follow-up[2] (79.1% of eyes showed no change or gained one or more Snellen lines), and also with the corresponding figure in other series with 18 months follow-up (Gartry[7]: 82%, Piebenga[21]: 85%). 5 eyes (9.8%, all from high myopia group) even demonstrated an improvement in best spectacle corrected vision, a finding similar to that of Gartry,[7] where 8 eyes (6.7%) demonstrated an improvement. This improvement is probably due to increased retinal image size.

The general preservation of best-corrected visual acuity may be the reason for the high level of satisfaction. Overall 86.3% of the operated eyes were said to be very satisfactory or satisfactory. This result is similar to that of Fichte[22] and Gimbel.[23] It is not surprising to see that there was no statistically significant difference in the level of satisfaction among the three myopia groups, as there was no significant difference in the proportion of eyes losing best corrected vision in the three groups.

## Conclusion

Excimer laser photorefractive keratectomy is shown to be an effective and safe procedure for correcting myopia in the low to moderate range. In patients with high myopia, the achieved results are less predictable and regression was more pronounced than those with low or moderate myopia.

**Table 4. Change in best corrected visual acuity by Snellen Lines.**

| Change in Best Corrected Visual Acuity By Snellen Lines Number of eyes (%) | | | | | |
|---|---|---|---|---|---|
| Group/Time | Total Eyes | None | + 1 or more | -1 | -2 or more |
| Low myopia | | | | | |
| 1 month | 15 | 11 (73.3) | - | - | 4 (26.7) |
| 6 months | 11 | 6 (54.5) | - | 5 (45.5) | - |
| 1 year | 7 | 5 (71.4) | - | 2 (28.6) | - |
| 1-1/2 years | 7 | 6 (85.7) | - | 1 (14.3) | - |
| 2 years | 15 | 14 (93.3) | - | 1 (6.7) | - |
| Moderate myopia | | | | | |
| 1 month | 15 | 8 (53.3) | - | 3 (20.0) | 4 (26.7) |
| 6 months | 13 | 7 (53.8) | - | 4 (30.8) | 2 (15.4) |
| 1 year | 9 | 8 (88.9) | - | 1 (11.1) | - |
| 1-1/2 years | 9 | 8 (88.9) | - | 1 (11.1) | - |
| 2 years | 15 | 14 (93.3) | - | 1 (6.7) | - |
| High myopia | | | | | |
| 1 month | 21 | 12 (57.1) | - | 4 (19.0) | 5 (23.8) |
| 6 months | 20 | 14 (70.0) | 3 (15.0) | 2 (10.0) | 1 (5.0) |
| 1 year | 18 | 10 (55.6) | 2 (11.1) | 6 (33.3) | - |
| 1-1/2 years | 17 | 9 (52.9) | 4 (23.5) | 4 (23.5) | - |
| 2 years | 21 | 14 (66.7) | 5 (23.8) | 2 (9.5) | - |

**Table 5. Corneal clarity scores at 2 years.**

| Group | O & trace | 1+or more |
|---|---|---|
| Low myopia | 15 | 0 |
| Moderate myopia | 13 | 2 |
| High myopia | 19 | 2 |

**Table 6. Level of satisfaction.**

| Group | Very satisfied or satisfied | Fairly satisfied or dissatisfied |
|---|---|---|
| Low myopia | 12 | 3 |
| Moderate myopia | 12 | 3 |
| High myopia | 20 | 1 |

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