

Excimer laser *in situ* keratomileusis for severe ametropia after penetrating keratoplasty

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Abstract

Objective: To evaluate the effects of laser *in situ* keratomileusis in correcting severe myopia and astigmatism after penetrating keratoplasty.

Methods: Laser *in situ* keratomileusis was performed to correct high ametropia in nine eyes of nine patients who had previously undergone penetrating keratoplasty.

Results: After laser *in situ* keratomileusis, all grafts remained clear and no corneal graft rejection occurred during the follow-up period. The average spherical equivalent refraction decreased from -12.17 diopters preoperatively to -3.56 diopters postoperatively and the average cylinder from 6.39 diopters to 2.78 diopters. The highest cylinder correction attempt was 10.00 diopters. The uncorrected visual acuity and the best corrected visual acuity improved for all patients.

Conclusion: Laser *in situ* keratomileusis is a safe and effective method for treating high ametropia after penetrating keratoplasty.

and irregular astigmatism. As a result, postoperative visual rehabilitation is jeopardized. Corneal refractive surgery such as radial keratotomy, photorefractive keratectomy and laser *in situ* keratomileusis (LASIK) can help to treat ametropia after PKP. This article reports the preliminary results of excimer laser corneal refractive surgery to correct high ametropia after PKP.

Patients and methods

From 1996 to 1999, LASIK was performed in nine eyes of nine patients who had severe ametropia after PKP. Patients were selected as follows:

- with a clear corneal graft at least 1 year after PKP
- all corneal sutures removed more than 6 months previously.

All patients had severe anisometropia and aniseikonia that could not be corrected with spectacles or contact lenses. The preoperative examinations included uncorrected visual acuity (UCVA), best corrected visual acuity (BCVA), slit-lamp biomicroscopy, complete ocular fundal examination with indirect ophthalmoscope, refraction examination, corneal thickness measurement with ultrasonic corneal pachymeter, intraocular pressure measurement with non-contact tonometry, and keratometric and corneal topographic examination.

The indications for PKP and other preoperative data are presented in detail in **Table 1**. In this group of patients, the mean age was 29.9 years (range, 19 - 56 years), the UCVA ranged from 0.01 to 0.2, the average preoperative spherical equivalent was -12.17 ± 5.58 diopters (D; range, -6.00 - -22.25 D), average astigmatism was 6.39 ± 3.12 D (range, 3.00 - 11.00 D), the BCVA ranged from 0.4 - 1.2, mean keratometric reading was 48.01 ± 3.40 D (range, 43.93

Key words: Excimer laser, Keratoplasty, Refractive error

Introduction

Penetrating keratoplasty (PKP) is an effective procedure for improving vision for patients with corneal diseases such as scarring, opacities, or dystrophy. However, even with refined and modern techniques, PKP may be complicated by high myopia, severe astigmatism or both, which are difficult to correct. In this situation, patients are often intolerant to spectacles or contact lenses because of acquired anisometropia

Table 1. Preoperative data of nine patients undergoing laser *in situ* keratomileusis after penetrating keratoplasty

Patient no.	Age	Sex	Eye	Reason for PKP (procedure)	UCVA	Refraction	BCVA	K-value	Difference K-value	Pachymetry (μm)
1	25	M	OS	Corneal penetrating injury (PKP+IOL)	0.2 (20/100)	-10.50/-3.00 x 160	0.8 (20/25)	46.25	4.75	528
2	56	M	OS	Corneal ulcer, perforation (PKP+IOL)	0.1 (20/200)	-20.50/-3.50 x 55	0.4 (20/50)	51.50	5.75	575
3	36	M	OS	Herpes simplex scarring (PKP+AK)	0.08 (20/250)	-4.00/-5.50 x 35	0.6 (20/30)	47.75	4.75	537
4	30	M	OD	Keratoconus (PKP)	0.08 (20/250)	-10.00/-10.50 x 140	0.4 (20/50)	54.43	12.63	529
5	19	M	OS	Keratoconus (PKP)	0.06 (20/330)	-4.00/-9.50 x 170	1.0 (20/20)	45.31	7.62	482
6	23	M	OS	Keratoconus (PKP)	0.03 (20/660)	-0.50/-11.00 x 170	1.2 (20/16)	46.00	10.00	532
7	25	M	OS	Keratoconus (PKP)	0.01 (20/2000)	-15.25/-4.50 x 90	0.6 (20/30)	50.37	4.00	569
8	26	M	OD	Keratoconus (PKP)	0.2 (20/100)	-5.00/-4.00 x 20	1.0 (20/20)	46.56	7.38	544
9	29	M	OS	Keratoconus (PKP)	0.1 (20/200)	-11.00/-6.00 x 155	1.0 (20/20)	43.93	4.13	567

Abbreviations: PKP= penetrating keratoplasty; OS = left eye; OD = right eye; IOL = intraocular lens; UCVA = uncorrected visual acuity; BCVA = best corrected visual acuity; K-value = keratometric reading; difference K-value = K_1-K_2 ; AK = astigmatic keratotomy

- 54.43 D), differences in keratometric reading (K_1-K_2) was 6.78 ± 2.95 D (range, 4.00 - 12.63 D).

Automated microkeratome (automated corneal shaper or Hansatome, Chiron Technolas, Florida, USA) was used to create a 160 μm lamellar corneal flap and the 193 nm argon fluoride excimer laser system (Keracor 116, Chiron Technolas, Munich, Germany) or VISX star was used to perform laser ablation with an energy density of 180 mJ/cm², and a repetition rate of 10 Hz; the ablation zone diameter was 6.0 to 7.0 mm. The laser ablation was centered on the pupillary position and not on the corneal graft.

After surgery, 0.3% gentamicin eye drops and 0.1% fluorometholone was administered three to four times daily and was continued on a tapering schedule for 3 to 4 weeks. Follow-up was scheduled for 1 day, 3 days, 1 week, 1 month, 3 months, 6 months, and 1 year postoperatively.

Results

In this study, the mean time interval between PKP and LASIK was 34 months (range, 12 - 85 months; **Table 2**). The mean follow-up time after LASIK was 12 months (range, 6 - 24 months). After LASIK, all grafts remained clear without evidence of rejection or decompensation. No other complications occurred except undercorrection.

After LASIK, the UCVA ranged from 0.2 - 1.2 and average spherical equivalent of refraction was -3.56 ± 3.41 D (range, 0.25 - -9.50D) with an average change of 8.61 D from the pre-operative spherical equivalent. The average postoperative astigmatism was 2.78 ± 1.84 D (range, 0.50 - 6.00 D) with a mean reduction of 3.61 D. The BCVA ranged from 0.7 - 1.2 and was improved for all patients. The mean keratometric reading was 42.31 ± 2.58 D (range, 36.37 - 45.75 D). The differences in keratometric reading (K_1-K_2)

Table 2. Postoperative data of nine patients undergoing laser *in situ* keratomileusis after penetrating keratoplasty

Patient no.	Interval (months)	UCVA	Refraction	BCVA	K-value	Difference K-value	Pachymetry (μm)	Follow-up (months)
1	15	0.8 (20/25)	-2.00/-4.00 x 135	1.2 (20/16)	43.68	4.87	403	12
2	18	0.3 (20/60)	-6.50/-6.00 x 10	0.7 (20/30)	42.56	5.38	429	13
3	14	1.0 (20/20)	-1.25 x 30	1.2 (20/16)	44.25	2.50	455	11
4	78	0.8 (20/25)	-6.00/-0.50 x 160	0.8 (20/25)	45.75	3.00	406	13
5	12	0.4 (20/50)	-1.25/-5.00 x 160	1.2 (20/16)	41.93	6.63	369	24
6	20	0.7 (20/30)	-2.50 x 175	1.2 (20/16)	42.14	4.29	442	17
7	54	0.2 (20/100)	-5.50/-2.50 x 70	0.8 (20/25)	41.91	2.71	439	6
8	85	1.0 (20/20)	-0.50/+1.50 x 140	1.2 (20/16)	42.18	5.13	501	6
9	14	1.2 (20/16)	-1.00/+1.75 x 60	1.2 (20/16)	36.37	2.50	416	7

Abbreviations: Interval = interval between PKP and LASIK; PKP = penetrating keratoplasty; LASIK = laser *in situ* keratomileusis; UCVA = uncorrected visual acuity; BCVA = best corrected visual acuity; K-value = keratometric reading; difference K-value = K_1-K_2 .

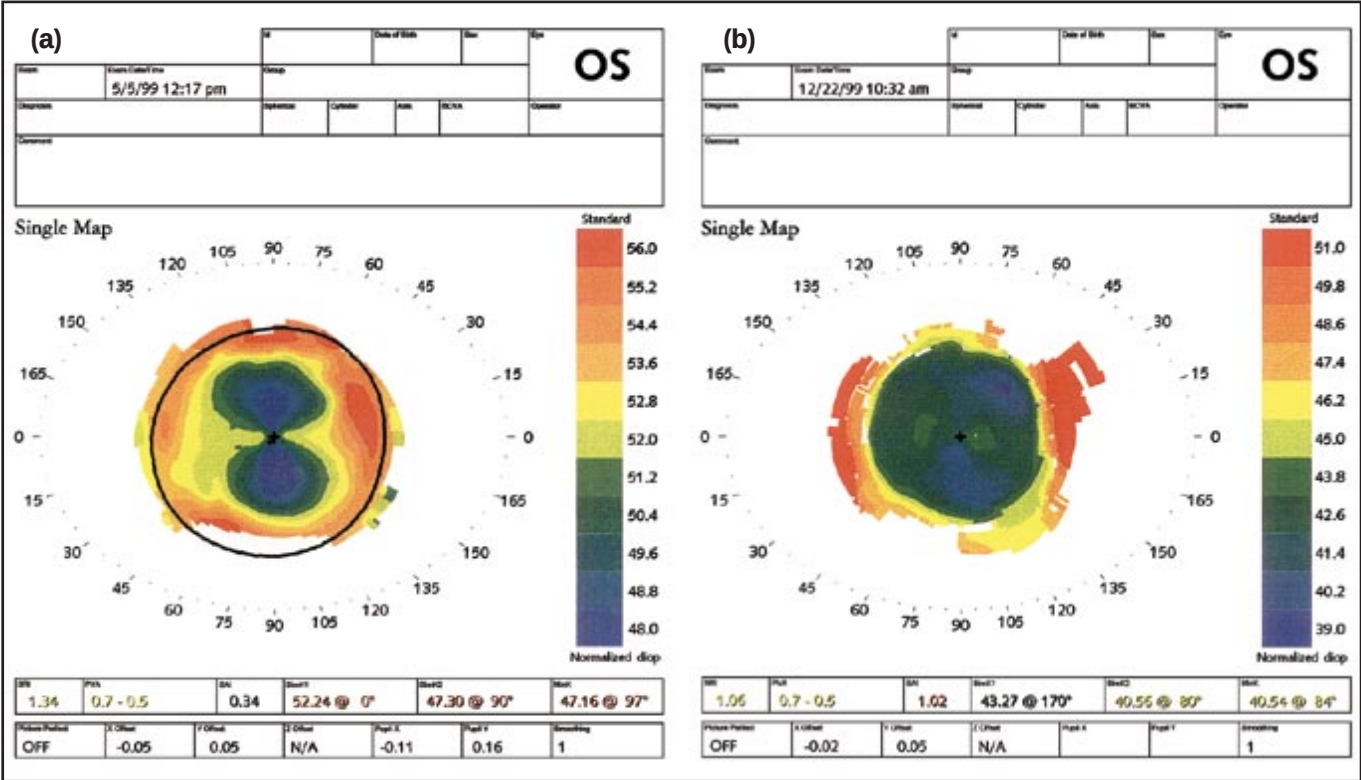


Figure 1. Pre- and postoperative corneal topographic changes in patient 7 (a) after penetrating keratoplasty and before laser *in situ* keratomileusis, and (b) seven months after laser *in situ* keratomileusis.

was 4.11 ± 1.50 D (range, 2.50 - 6.63 D) with an average change of 2.67 D. The corneal topographies of two patients before and after the procedure are shown in **Figures 1 and 2**.

Discussion

Severe ametropia, especially high astigmatism and anisometropia after successful penetrating keratoplasty, is a

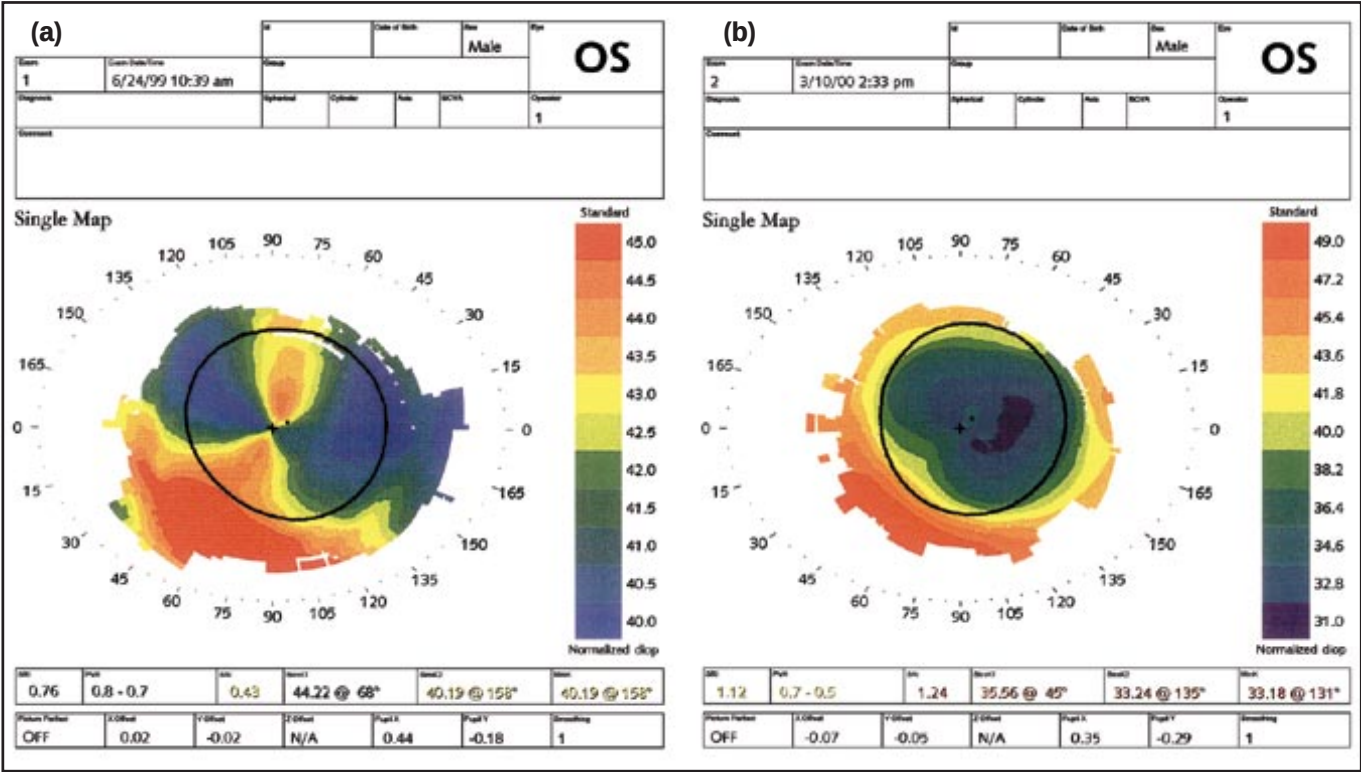


Figure 2. Pre- and postoperative corneal topographic changes in patient 9 (a) after penetrating keratoplasty and before laser *in situ* keratomileusis, and (b) eight months after laser *in situ* keratomileusis.

problem that ophthalmic surgeons have to consider. Ophthalmologists have been looking for the ideal method to solve this problem for some time. Results of methods such as adjusting the sutures during or after PKP surgery, a wedge-shaped corneal excision made at the flatter meridian of the cornea, and relaxing keratotomy¹ have been reported. However, predictabilities are low and the results are unsatisfactory. In recent years, corneal refractive surgeries have provided many new options for solving this problem.

Radial keratotomy (RK) was first used to correct severe anisometropia after PKP.² RK had good results in correcting low and moderate myopia and asymmetric astigmatism, but may cause a further endothelial cell loss if perforation occurs and it has been shown to have poor predictability and stability. Photorefractive keratectomy (PRK) which ablates and reshapes the corneal surface with excimer laser has been shown to correct myopia and astigmatism quite precisely, but it has proved to be effective only for correcting low and moderate degrees of ametropia and has the possibility of inducing haze in the cornea.^{3,4} Some reports demonstrate that the donor graft's PRK reaction is more severe than for normal corneal tissue which may result in more corneal haze.³ The latest method is LASIK.⁵⁻⁸ The range of myopia that can be treated with LASIK is wide and includes low to extremely high ametropia. The predictability of LASIK has also been shown to be better than other methods.

Choosing the right time for refractive surgery is the key to success. Early PRK after PKP may cause extensive reaction of the corneal tissue³ because wound healing after PKP is still not complete, which may lead to a higher incidence and

degree of haze when compared with later PRK. On the other hand, early LASIK after PKP may lead to a higher chance of wound dehiscence. Some authors advocate that the interval between PKP and LASIK should be at least 2 years in order to sustain the increased intraocular pressure caused by the suction ring of the microkeratome.⁸ However, in some situations, patients wish to regain their visual acuity and binocular visual function as soon as possible to meet their work and study needs. It has been recommended that the shortest time should be at least 1 year after PKP. In this group, the interval was only 1 year for one patient and wound dehiscence did not occur.

Some reports evinced that the therapeutic effect of excimer laser in correcting the high astigmatism after penetrating keratoplasty is only about 50%. In this study, the mean astigmatism value decreased 56% from the preoperative value, which is similar to other reports. This result is probably related to corneal irregularity and asymmetric astigmatism after PKP, but the current software for the excimer laser system is designed for the symmetric geometric ablation mode. Therefore, the effects of correcting special astigmatism are unsatisfactory. The corneal topographic system plays an important role in providing entire and accurate data for displaying regular and irregular astigmatism and the properties of the corneal surface. With corneal topography, the corneal surface changes can be studied before and after refractive surgery. Therefore, if a new type of excimer laser system that can be induced by corneal topography to ablate the cornea is designed, it may reshape the corneal surface with a different energy density to different areas and allow instantaneous observation during the operation. This type of system would give us a brighter future for solving this type of problem.

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