Laser in situ Keratomileusis and Diode Thermal Keratoplasty for Correction of Hyperopia From +5.00 to +10.00 Diopters

Ahmad Salamat Rad, MD; Mahmood Jabbarvand, MD; Mohammad Mehdi Farahvash, MD; Arash Kheradvar, MD

ABSTRACT

PURPOSE: To evaluate the effects and safety of laser in situ keratomileusis (LASIK) and diode thermal keratoplasty (DTK) for correction of moderate to high hyperopia (+5.00 to +10.00 D).

METHODS: This prospective study included 30 eyes of 15 patients who had LASIK-DTK bioptics. The median age of the patients was 50.5 years. LASIK was performed using a Nidek EC-5000 excimer laser system and DTK by a Prolaser DTK laser, 2 months after LASIK. Follow-up ranged from 9 to 12 months (mean, 10.5 mo).

RESULTS: The mean preoperative spherical equivalent refraction was +8.25 ± 0.25 D and mean postoperative was +1.00 ± 0.50 D. The preoperative best spectacle-corrected visual acuity (BSCVA) was ≤20/40 in 10 eyes and ≥20/25 in 20 eyes. Postoperatively, BSCVA was ≤20/40 in 8 eyes and ≥20/25 in 22 eyes. No significant intra- or postoperative complications occurred.

CONCLUSION: LASIK-DTK bioptics for correction of moderate to high hyperopia (+5.00 to +10.00 D) was safe and effective. In this method, two different ablative and non-ablative laser systems were used to compensate for regression, which is the most important concern in the correction of hyperopia. [*J Refract Surg* 2002;18(suppl): S318-S320]

Although the correction of myopia has been a focus of intense interest with great success, surgical correction of hyperopia has remained an elusive goal. Many procedures have been proposed with encouraging results, however, over time most of them have been abandoned because of loss of effect or induced astigmatism or both. Epikeratophakia and hexagonal keratotomy are two known examples.[1-4]

Because of the success of photorefractive keratectomy (PRK) and laser in situ keratomileusis (LASIK) in reshaping the cornea, the use of toroidal ablations to correct hyperopia has been widely accepted. The most important concern is regression, which is proposed to be due to unknown tissue reactions and collagen remodeling.[5-11]

Heat-induced focal coagulation of the corneal stroma has long been used to reshape the anterior cornea to correct hyperopia and astigmatism. The use of a pulsed holmium:YAG laser, either contact or non-contact, and a continuous wave contact diode laser as a source of focusing energy into the corneal stroma was introduced by several authors.[12-16] Again, the most important concern is regression, which may due to inappropriate absorption, inaccurate focusing, and collagen necrosis. Induced astigmatism is the second concern, which may result from incorrect positioning of the laser and unequal pressure on the cornea in contact modes.[14,16,17]

The idea of performing two different surgical approaches to correct a high refractive error was first introduced by Zaldivar and colleagues, and named "Bioptics."[18] Guell and colleagues[19] and Pop and colleagues[20] used a similar approach on high myopic, hyperopic, and postoperative cataract extraction cases.

This study was conducted to evaluate the effects of LASIK-DTK bioptics for correction of hyperopia of +5.00 to +10.00 diopters (D).

PATIENTS AND METHODS

We included prospectively 30 eyes of 15 patients who had LASIK-DTK bioptics, seven males (14 eyes) and eight females (16 eyes). Median patient age was 50.50 years (range 38 to 63 yr).

From Novin Didegan Eye Clinic, Tehran, Iran.

Presented at the Seventh Annual Nidek International Excimer Laser Symposium, December 14-15, 2001, Monte Carlo, Principality of Monaco.

Correspondence: Ahmad Salamat Rad, MD; Novin Didegan Eye Clinic, PO Box 13185-773, Tehran, Iran. Tel: 98.21.6464320; Fax: 98.21.6417105; E-mail: asalamatrad@iranmedical.com

Table 1
ASR Nomogram for DTK V.1.1 (Laser Power 180 mW)

Refraction (D)	Age ≤40 Yr			Age >40 Yr		
	TZD*	Rings	Spots	TZD*	Rings	Spots
+1.00 to +2.00	6	2	16	7	2	16
+2.00 to +3.00	7	2	24	6	2	16
+3.00 to +4.00	6	2	24	7	2	24
+4.00 to +5.00	6	2	24†	6	2	24

*Treatment zone diameter (mm)
†Exposure time: 4.5 sec

Before surgery, all patients underwent a complete evaluation of the anterior segment using a Haag-Streit 900 slit lamp (Haag-Streit, Bern, Switzerland) and Welsh-Allyn indirect ophthalmoscope (Welsh-Allyn, New York, NY). Refraction was performed by a Nidek AR-600 Auto refractometer (Nidek, Gamagori, Japan) and retinoscopic cyclorefraction was also done. Corneal topography was performed using a CSO system (CSO, Milan, Italy) and pachymetry by a Nidek UP-1000 ultrasonic pachymeter.

One surgeon (ASR) performed all operations. The laser systems used in this study were the Nidek EC-5000 for LASIK (ablation zone, 5.5 mm; transition zone, 8 mm; fluence, 110 to 120 mJ; repetition rate, 34 Hz) and the Prolaser DTK machine (Prolaser Medical, Dusseldorf, Germany) for DTK. For DTK, the first treatment zone was 6 and 7 mm (depending on the nomogram), the second was 7 and 8 mm (depending on the nomogram), number of spots was 8 to 24 (depending on the nomogram), laser energy was 180 mW, and exposure time/spot was 4.0 sec. We used a Moria Evolution 2 and a CB microkeratome (Moria, Antony, France) for creating corneal flaps.

LASIK was performed for up to +5.00 D and then DTK for the remaining refractive error after 2 months. We used 130% of the hyperopic Nidek nomogram for LASIK and the ASR nomogram version 1.1 for DTK (Table 1). Chloramphenicol and betamethasone drops were prescribed after LASIK for 10 days and chloramphenicol and diclofenac drops after DTK for 1 week. Mean follow-up was 10.5 months (range 9 to 12 mo after DTK).

RESULTS

Mean preoperative spherical equivalent refraction was +8.25 ± 0.25 D (range +6.25 to +9.50 D). Preoperative best spectacle-corrected visual acuity (BSCVA) was ≤20/40 in 10 eyes and ≥20/25 in 20 eyes.

Table 2
Clinical Data for LASIK-DTK Eyes

	Preoperative (range)	Postoperative (range)
Mean spherical equivalent refraction (D)	+8.25 ± 0.20 (+6.25 to +9.50)	+1.00 ± 0.50 (-0.25 to +2.00)
Best spectacle-corrected visual acuity	≤20/40 10 eyes ≥20/25 20 eyes	≤20/40 8 eyes ≥20/25 22 eyes

We examined eyes after refractive surgery on days 1, 3, 7, 15, and then every month. The examination included slit-lamp microscopy, intraocular pressure measurement and refraction. We performed cyclorefraction, topography, and pachymetry again before DTK.

At the end of the study mean spherical equivalent refraction was +1.00 ± 0.50 D (range, -0.25 to +2.00 D) and BSCVA was ≤20/40 in 8 eyes and ≥20/25 in 22 eyes. The preoperative and postoperative clinical data are summarized in Table 2.

We did not encounter any significant complications during LASIK or DTK. The most important postoperative complications were induced astigmatism mainly after DTK and regression of hyperopia after both procedures. The mean induced postoperative DTK astigmatism was -1.75 ± 0.50 D, which was resolved in all eyes but one after 6 months.

We performed selective DTK in minus cylinder axis in the eyes of the above mentioned patient and the cylinder resolved postoperatively. The status of endothelial cells after DTK was evaluated by high magnification slit-lamp microscopy and no significant change was seen.

The regression of hyperopia was seen in all eyes; mean regression was +1.50 ± 0.40 D (range, +0.75 to +2.50 D).

From the viewpoint of patients, postoperative pain and glare were the two most important problems. The former was experienced mainly after DTK and the latter was experienced after both procedures.

DISCUSSION

The correction of hyperopia by laser keratorefractive procedures has not been completely effective in the last two decades. Regression, which is probably due to multiple factors such as different tissue responses, collagen remodeling, low tissue penetration, ethnic differences, and different nomograms, is the most important concern.[6-10,12-15]

The history of bioptics, or using two different refractive procedures for correction of one refractive error, is not long and began with the studies of Zaldivar and co-authors.[18] They performed phakic intraocular lens implantation and LASIK for the correction of high myopia. Others performed similar procedures such as iris claw lens and LASIK or clear lensectomy and PRK or LASIK to correct high hyperopia or myopia.[19,20]

In this prospective study, we evaluated the effectiveness of LASIK-DTK bioptics for correction of hyperopia of +5.00 to +10.00 diopters. Regarding the results of single refractive surgery[5-11,12-15], our results were better and more stable. We speculate that using two different ablative and non-ablative laser surgeries may enhance the magnitude of effect and possibly control regression by decreasing the amount of tissue ablation by LASIK and increasing tissue penetration by performing DTK in previously thinned tissue.

We had no significant complications such as epithelial or flap related problems, inflammation, or infection. Although the effect of intraocular lens implantation (phakic or pseudophakic) plus LASIK is much greater than our method, the possibility of complications from performing intraocular surgery is a concern. We think that the combination of intraocular and keratorefractive procedures is still the best method for correcting hyperopia of more than +10.00 D.

LASIK followed by DTK is an effective and safe method for the correction of hyperopia. The predictability is high but will be improved by performing more studies in different ethnic groups and introducing new nomograms.

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