One-year Clinical Results of Photorefractive Keratectomy With a Solid-state Laser for Refractive Surgery

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ABSTRACT

PURPOSE: To investigate the safety, efficacy, and stability of photorefractive keratectomy (PRK) performed with a newly developed solid-state laser after 1-year follow-up.

METHODS: The all-solid-state, Q-switched, frequency-shifted laser (LaserSoft; Katana Technologies, Berlin, Germany) with a Gaussian spot diameter of 0.2 mm and repetition rate of 1 kHz was used. Eleven eyes of six patients were treated with PRK. The mean outcome measures were uncorrected visual acuity (UCVA), best spectacle-corrected visual acuity (BSCVA), corneal topography, and corneal transparency. All patients were evaluated at 1, 3, 6, and 12 months postoperatively.

RESULTS: At 12-month follow-up no eye lost lines of BSCVA and UCVA improved in all eyes. All eyes were within ±1.00 diopters (D) and 8 (73%) eyes were within ±0.50 D of emmetropia.

CONCLUSIONS: Clinical results at 1 year were promising, with good safety, efficacy, and stability of the visual and refractive outcome. [*J Refract Surg.* 2006;22:611-613.]

Laser vision correction has been successfully performed using excimer lasers as ultraviolet sources.[1] During the past 10 years, solid-state lasers have improved to become a reliable source for treating organic and inorganic tissue materials.[2-7] The advantage is a considerable reduction of problems associated with excimer lasers, permitting a high pulse-to-pulse stability, smaller spot size, and higher repetition rate. Due to the absence of gas, solid-state laser maintenance costs are lower and noise level during operation is significantly less.

Our previous report presents experimental investigations performed with a solid-state laser on porcine eyes and clinical results at 1 month postoperatively.[8] This report presents clinical results of refractive procedures using a solid-state laser in human eyes with 12-month postoperative follow-up.

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PATIENTS AND METHODS

Refractive procedures were performed with the small spot size, high-repetition rate, all-solid-state LaserSoft (Katana Technologies, Berlin, Germany), which is a stabilized, tunable short-pulse, Q-switched, frequency-shifted, and diode-pumped laser. Sequential frequency conversions chain with nonlinear crystals to shift the wavelength of the laser radiation to a range between 200 and 210 nm. The spot in the target plane has a Gaussian intensity distribution with a beam diameter D of 0.25 mm, taken at 1/e-level of peak fluence Fo (Fo = $4E/\pi D2$, where E is the laser pulse energy). The measured shot-to-shot stability is 1.4% of the root-mean-square in deep ultraviolet light. Repetition rate was set to 1 kHz. The laser's continuously working eye tracker system has a latency of 1 millisecond.

Eleven eyes of six patients underwent PRK. Preoperative assessment included uncorrected visual acuity (UCVA), best spectacle-corrected visual acuity (BSCVA), tonometry, corneal topography, corneal thickness, cycloplegic refraction, ophthalmoscopy, pupillometry, Schirmer's test, and endothelial microscopy. Patients were excluded if they had change in refraction within the past year, corneal pathology, glaucoma, or systemic diseases (eg, diabetes and immunologic disorders). Informed consent was obtained from all patients. Two surgeons (A.M.R., G.F.) performed PRK after alcohol de-epithelialization with the eye tracking system engaged. Spot diameter was 0.2 mm and the ablation zone varied up to 10 mm. A soft contact lens was applied for 4 days after treatment until the epithelium healed. All patients received drops of antibiotics, non-steroidal anti-inflammatory agents, and artificial tears 4 times daily until the contact lenses were removed. The patients were given corticosteroid drops 3 times daily for 30 days and successively two times daily for 30 days. Examinations were performed at 1, 3, 6, and 12 months postoperatively, and UCVA, BSCVA, corneal topography, and transparency were assessed.

RESULTS

Preoperative UCVA was ≤20/100 in 7 eyes, 20/50 in 3 eyes, and 20/40 in 1 eye. Twelve months after treatment UCVA was ≥20/32 in 11 eyes, ≥20/25 in 8 eyes, and ≥20/20 in 7 eyes. Preoperative BSCVA was ≥20/25 in 11 eyes and ≥20/20 in 8 eyes. After 12 months no eye lost lines of BSCVA and all eyes were ≥20/20. Preoperative spherical equivalent refraction varied from −7.63 to +1.50 D (average −2.82±3.16 D) and was between −1.00 D

TABLE

Individual Visual Acuity and Refractive Data Before and After PRK With a Solid-state Laser

	Preoperative					6 Months Postoperative				
Eye	UCVA	BSCVA	Sphere	Cylinder	SE	UCVA	BSCVA	Sphere	Cylinder	SE
1	<20/200	20/25	−7.00	−1.00	−7.50	20/30	20/20	−0.50	−1.25	−1.13
2	<20/200	20/20	−7.00	−1.25	−7.63	>20/20	>20/20	0.00	0.00	0.00
3	20/50	20/20	1.00	1.00	1.50	20/20	20/20	−0.50	0.00	−0.50
4	20/50	20/20	1.00	0.75	1.38	>20/20	>20/20	0.00	0.00	0.00
5	20/100	20/20	−1.75	0.00	−1.75	>20/20	>20/20	0.00	0.00	0.00
6	20/40	20/20	−1.25	0.00	−1.25	>20/20	>20/20	0.00	0.00	0.00
7	20/100	20/20	−1.25	−1.00	−1.75	>20/20	>20/20	0.00	0.00	0.00
8	20/50	20/20	−1.50	0.00	−1.50	>20/20	>20/20	0.00	0.00	0.00
9	<20/200	20/20	−2.75	0.00	−2.75	20/30	20/20	−0.50	0.00	−0.50
10	<20/200	20/20	−4.00	0.00	−4.00	20/30	20/20	−1.25	0.00	−1.25
11	<20/200	20/20	−6.00	0.00	−6.00	20/50	20/20	−1.00	0.00	−1.00

UCVA = uncorrected visual acuity, BSCVA = best spectacle-corrected visual acuity, SE = spherical equivalent refraction

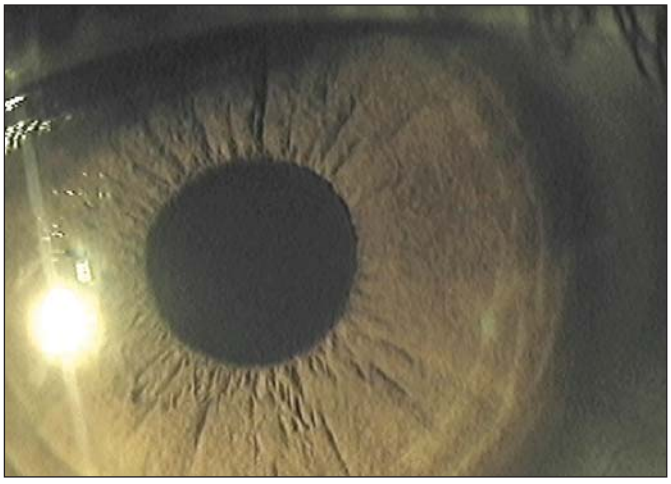

Figure. Corneal transparency 1 year after treatment.

and emmetropia after 12 months (average −0.34±0.42 D). All eyes were within ±1.00 D of emmetropia and 8 (73%) eyes were within ±0.50 D of emmetropia (Table). Corneal maps demonstrated a smooth, regular pattern with wide, well-centered, ablation zones. No eye developed ocular hypertension. Corneal transparency was observed in 9 eyes (Fig). One patient had trace haze in both eyes (eyes 9 and 10) at 3 months.

DISCUSSION

This study reports the first clinical results of PRK performed with a solid-state laser and demonstrates good efficacy, safety, and stability after 1-year follow-up. Small spot size and high pulse-to-pulse stability make this solid-state laser platform a good choice for customized corneal ablation and an alternative to fluorine-based excimer lasers for correction of refractive errors.

An important aspect of the small spot diameter is the considerably lower mechanical stress caused by the acoustic shock wave generated in the ablation process. Krueger et al[7] measured these acoustic shock waves, and concluded that their amplitude increases with increasing spot diameter. Kermani and Lubatschowski[9] reported that the mechanical stress involved in laser-induced acoustic shock waves may produce cellular alterations that damage the collagen structure. In the solid-state laser, the high repetition rate (1 kHz) and the low energy per pulse resulted in a quiet treatment. No audible acoustic waves were generated.

Wide ablation zones, good transparency, stability of results, safety of treatment, and good predictability observed in this small group of patients is promising; however, further investigation is required with a greater number of eyes treated to confirm these data.

The new solid-state laser exhibits characteristics such as a small spot diameter with true Gaussian intensity distribution, high repetition rate, and silent operation. The beam profile induces a smooth surface after treatment and smooth and well-defined transition zones. The solid-state approach reduces the require-

12 Months Postoperative				
UCVA	BSCVA	Sphere	Cylinder	SE
20/25	20/20	−0.50	−1.00	−1.00
>20/20	>20/20	0.00	0.00	0.00
20/20	20/20	0.00	0.00	0.00
>20/20	>20/20	0.00	0.00	0.00
>20/20	>20/20	0.00	0.00	0.00
>20/20	>20/20	0.00	0.00	0.00
>20/20	>20/20	−0.50	0.00	−0.50
20/20	>20/20	0.00	0.00	0.00
20/30	20/20	−0.75	0.00	−0.75
20/50	20/20	−1.00	0.00	−1.00
20/50	20/20	−1.00	0.00	−1.00

ments for maintenance and the related costs, and the diode pumping system features long lifetime and efficiency.

The authors believe that after technical improvement, the effectiveness of treatment was obtained and this laser could be used for refractive surgery as an alternative to a standard excimer laser.

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Epi-LASIK After Amputation of a LASIK Flap

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ABSTRACT

PURPOSE: To demonstrate the feasibility of performing epi-LASIK after amputation of a LASIK flap.

METHODS: Three months following complicated primary LASIK and immediate flap amputation, a Lasitome microkeratome (Gebauer, Neuhausen, Germany), equipped with an epi-head and -blade, was used to perform an epi-LASIK surface ablation.

RESULTS: Despite uneven stromal contour at the site of the original hinge after amputation of the LASIK flap, the microkeratome passage was uneventful, resulting in a regular epithelial flap. Laser ablation was performed and the epithelial flap was repositioned.

CONCLUSIONS: Epi-LASIK was completed with no intraoperative complication in the presence of an irregular stromal surface after amputation of a LASIK flap. This procedure may extend our options in the management of LASIK flap-related complications. [*J Refract Surg.* 2006;22:613-616.]

Epi-LASIK[1,2] is the latest refractive corneal ablation procedure, similar to laser subepithelial keratomileusis (LASEK),[3-12] in which a special blunt blade in a dedicated epi-LASIK head of a LASIK microkeratome creates epithelial flaps without the necessity of preceding treatment with an alcohol solution (Fig 1).

However, LASIK continues to be the method of

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