

Tikhov A.V., Kuznetsov D.V., Tikhov A.O., Tikhova E.V.

Analysis of the clinical results of refractive operations performed on the domestic solid-state laser system "OLIMP-2000 / 213-300Hz"

Our own experience in the development and operation of excimer laser refractive systems since 1998 (OLIMP 2000/193, registration certificate No. FS 02260220/2138-05 of 02.08.2005) allowed us to start mastering and implementing a new method for obtaining laser energy in the ultraviolet range, based on solid state laser technology (Solid State Laser System). This technology makes it possible to obtain high-coherent and energy-stable radiation by optical pumping of an Nd: YAG crystal (an aluminium yttrium garnet doped with neodymium) without the use of gas mixtures.

The original infrared radiation with a wavelength of 1064 nm is converted to the wavelength of the second (532 nm), third (355 nm) and fifth harmonics (213 nm) using three nonlinear crystals.

Solid-state technology for obtaining laser radiation has a number of technical and operational advantages in comparison with the classical excimer. In particular, the continuous operation of the optical resonator in the infrared, rather than in the ultraviolet, which significantly increases the technical life of optical elements, which is comparable with the resource of the laser system itself.

Radiation with a wavelength of 213 nm is practically not absorbed by water vapor and oxygen, which provides a great stability of energy indicators during the operational day. The practical value of this property of a solid laser refractive system is expressed in the absence of the need for mandatory calibrations of energy, regardless of the duration and intensity of the operational day. This significantly increases the possible number of operations per day.

Radiation with a wavelength of 213 nm allows to work in the so-called "wet ablation" mode. The surface of the cornea is ablated without drying, i.e. in the most physiological state of the stroma.

Our clinic in 2009 began the clinical introduction of solid-state laser technology. The experience gained during this time confirmed the new positive properties of the solid-state system for refractive surgery with a wavelength of 213 nm. Since mid-2013 in our clinic, all operations using the LASIK and MAGEK methods have been performed on a domestic solid-state laser diode-pumped "OLIMP -2000/213 -300Hz".

Goal

Analysis and evaluation of clinical results of refractive operations performed using the LASIK and modified photorefractive keratectomy (MAGEK) methods of ametropies of various degrees on the domestic solid-state laser system "OLIMP -2000/213 - 300Hz".

Material and methods

All operations were performed on the domestic laser system OLIMP -2000/213 -300Hz (registration certificate No. FSS 2010/08230 dated July 9, 2010), the wavelength was 213 nm, the energy in the pulse was 0.7 mJ, the generation frequency was 300 Hz, the forming system is a "flying spot", a free-inertial active tracking system in the visible spectrum with a capture on the limb.

In this study 301 patients (596 eyes) were operated, all patients were divided into two groups. The first group of patients was operated according to the LASIK technique (Moria Evolution 3 microkeratome, One Use Plus handle, 90 μ m head) - 116 patients (227 eyes) with hypermetropic refraction of the first degree (19 eyes) and second degree (13 eyes), as well as myopic refraction of the first (90 eyes), the second (89 eyes) and the third degree (16 eyes). The second group included 185 patients (369 eyes) operated with MAGEK (Mitomycin C, application time from 30 to 60 seconds) who had myopic refraction and including myopic refraction in combination with astigmatism in 275 cases. The first degree of myopia is 106 eyes, the second degree - 159 eyes, the third degree - 104 eyes.

All patients received an ophthalmological examination, including the determination of visual acuity without correction and with optimal correction (determination of subjective refraction), autorefractometry, computer corneal topography, biomicroscopy, contactless tonometry, autorefractometry in cycloplegia, reverse ophthalmoscopy, pachymetry. Patients were observed in the early postoperative period, as well as in 1, 3, 6-8 and 12 months. after operation. The obtained results were entered into the database and processed by standard methods of mathematical statistics.

The time of observation of patients at the time of writing was from 6 months. up to 13 months. In the first group there were patients with hypermetropia from +0.5 to +5.13 D, mean 2.69 ± 1.39 D; with myopia from -0.25 to -9.13 D, mean -3.44 ± 1.72 D; astigmatism from -0.75 to -4.0 D, average -1.24 ± 0.60 D. In patients with first degree hypermetropia, postoperative spheroequivalent refraction ± 1.0 D was in 100% cases; ± 0.5 D - in 89.5% cases; second degree hypermetropia ± 1.0 D was in 92.3% cases; ± 0.5 D - in 76.9% cases. BCVA before operation is 0.5 and more - 93.8%; 1,0 and more - 46,8%. UVA after operation 0.5 and above - in 90.6% of patients, 1.0 and above - in 43.8% of patients. In patients with myopic refraction of the 1st degree, postoperative refraction SE of ± 1.0 D was in 100% cases; ± 0.5 D - in 89.4% cases; 2th degree ± 1.0 D was in 100% cases; ± 0.5 D - in 82.0% cases; 3th degree ± 1.0 D was in 100% cases; ± 0.5 D - in 92.8% cases. BCVA before surgery is 0.5 and more than 99.5%; 1,0 and more - 80,4%. UCVA 0.5 and above - in 98.7% of patients, 1.0 and above - in 83.5% of patients. The loss of 1 or more lines of BCVA is 0%. Postoperative complications in this group were not observed.

Table 1. Results of the first group of patients (LASIK).

LASIK	Before surgery		After surgery	
	Refraction, SE \pm m, D	BCVA	Refraction, SE \pm m, D	UCVA
Myopia 1 st degree (90 eyes)	-2,03 \pm 0,63	0,98 \pm 0,07	0,04 \pm 0,33	1,01 \pm 0,10
Myopia 2 nd degree.(89 eyes)	-4,23 \pm 0,83	0,95 \pm 0,08	-0,13 \pm 0,32	1,00 \pm 0,13
Myopia 3 th	-7,13 \pm 1,00	0,92 \pm 0,12	-0,18 \pm 0,38	0,92 \pm 0,16

degree (16 eyes)				
Hypermetropia 1st degree (19 eyes)	1,73±0,93	0,88±0,16	0,23±0,30	0,90±0,14
Hypermetropia 2 nd degree 13 eyes)	4,03±0,62	0,77±0,26	0,54±0,30	0,83±0,24

In the second group of patients operated on by the MAGEK method, the value of myopic refraction is -0.5 D to -10.88 D, the average is -4.47 ± 2.26 D; astigmatism - from -0.75 D to -4.0 D, the average -1.47 ± 0.82 D. BCVA before surgery is 0.5 and more - 99.5%; 1.0 and more - 58,6%. Postoperative refraction by spheroequivalent in patients with myopia of 1st degree ± 1.0 D was in 100% cases; ± 0.5 D - 94.8%; 2th degree ± 1.0 D was in 100% cases; ± 0.5 D - 94.7%; 3th degree ± 1.0 D was in 98.0% cases; ± 0.5 D - 83.7%. UCVA 0.5 and above - in 100% of patients, 1.0 and above - in 75.4% of patients. The loss of 1 or more lines of BCVA is 0%. Postoperative complications: in 0.8% (3 cases), epitheliopathy was observed in the early postoperative period. When treated with corneoprotectants passed on average 5 to 7 days later. Regression in the long term after the operation (6-8 months) was observed in 1 patient, he was re-operated.

Table 2. Results of the second group of patients (MAGEK).

MAGEK	Before surgery		After surgery	
	Refraction, SE±m, D	BCVA	Refraction, SE±m, D	UCVA
Myopia 1 st degree (106 eyes)	-2,13±0,55	0,95±0,09	-0,07±0,34	1,00±0,13
Myopia 2 nd degree (159 eyes)	-4,28±0,86	0,94±0,09	-0,08±0,37	0,98±0,09
Myopia 3 th degree (104 eyes)	-7,57±1,21	0,87±0,13	-0,18±0,43	0,92±0,14

In both groups, the ratio of UCVA after surgery to the BCVA before surgery was $0.98 / 0.96 = 1.02$. The BCVA after the operation remained equal to the preoperative visual acuity in 99.6% of cases. Postoperative refraction in 91.9% of cases is in the range ± 0.5 D, in 98.8% cases the refraction is within ± 1.0 D. Only 0.5% (3 eyes from 596 eyes) fell within the range of ± 1.0 D to ± 2.0 D. On average, the spheroequivalent of myopic refraction was changed from -4.11 ± 2.14 D (before surgery) to -0.08 ± 0.37 D (in the postoperative period). The stability of the postoperative result after the LASIK procedure was 83.2%, after the MAGEK procedure 79.7%.

Clinical examples:

1. Patient B., 20 years old. Diagnosis: myopia OD III degree, OS II degree. Preoperative examination: subjective refraction Visus OD sph -5,75 cyl -0,75 ax17 = 1,0; Visus OS sph -5,5 cyl -0,5 ax175 = 1,0. Pachymetry OD 583 microns, OS 596 microns. IOP OD is 14 mmHg. OS - 15 mmHg. Ophthalmoscopy - myopic cone, peripheral dystrophy was not detected. In September 2013, an operation was performed on both eyes using the Lasik technique. In the postoperative period, in the first week, minor epitheliopathy was noted. To the standard scheme of postoperative treatment of Tobrazone, a Systane Ultra was prescribed. After 2 weeks, no signs of epitheliopathy were noted. The course of Dexamethasone up to 1 month. When examined at 6 months. the patient does not complain. Visus OD = 1.2; OS = 1.5 without correction. Autorefractometry OD sph + 0.25 cyl -0.5 ax13; OS sph + 0,25 cyl -0,5 ax10. The interface is clean (Figure 1).

Figure 1.

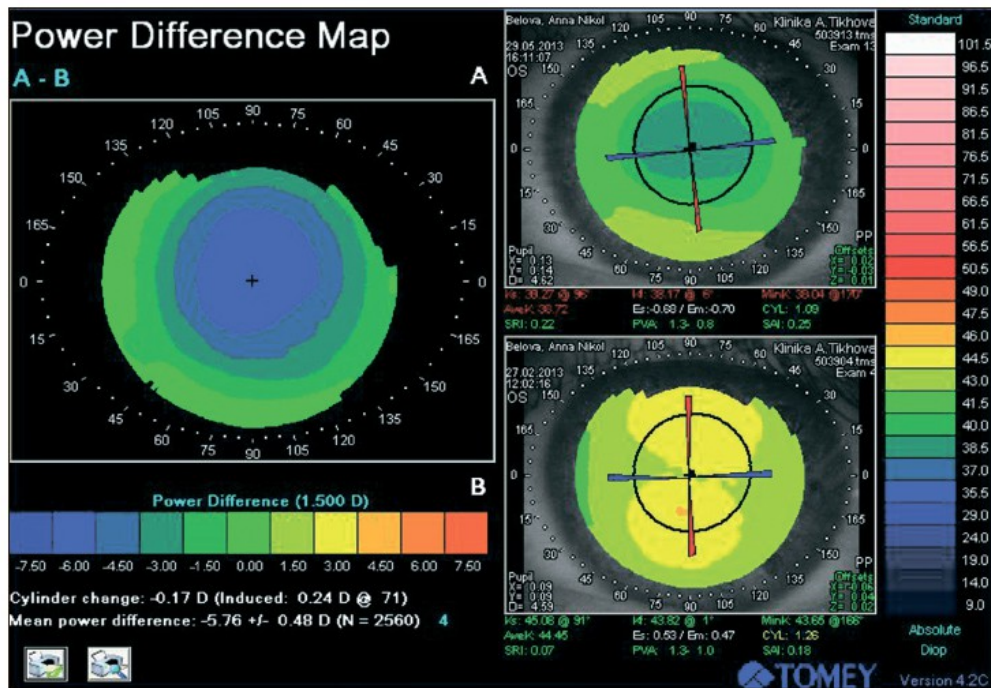


Рис. 1. Авторефрактометрия пациентки Б.

2. Patient Sh., 42 years old. Diagnosis: OD - complex hypermetropic astigmatism, hypermetropia 2th degree, OS - hypermetropia 2th degree. Pre-operative examination: UCVA OD = 0.6; OS = 0.8; Visus OD sph + 4.0 cyl -1.5 ax 87 = 1.0; OS sph + 3.5 = 1.0. Reserves of accommodation OD - 2.0 D, OS - 2.5 D. Pachymetry OD 550 μ m, OS 540 μ m. IOP OD - 16 mmHg, OS - 15 mmHg. Ophthalmoscopy without features. Given the anatomical features of the structure of the orbit (difficulty in installing the vacuum ring), as well as a noticeable ectopia of the pupils to the nose and displacement of the visual axis in the same direction, MAGEK was chosen as the procedure of the operation. In August 2013, both eyes were operated. The lenses were removed for 6 days, a course of Dexamethasone was prescribed for 2 months. In 1 month we noted transient myopia: autorefractometry OD sph -0.25 cyl -0.5 ax5; OS sph -0.25 cyl -0.75 ax12; UCVA OD = 0.9; OS = 0.7. After 1 year of operation, USVA OD = 1.0; OS = 1.0. Autorefractometry: OD sph + 0,25 cyl -0,5 ax123 OS sph + 0,75 cyl -0,5 ax59. (Figure 2)

Figure 2.

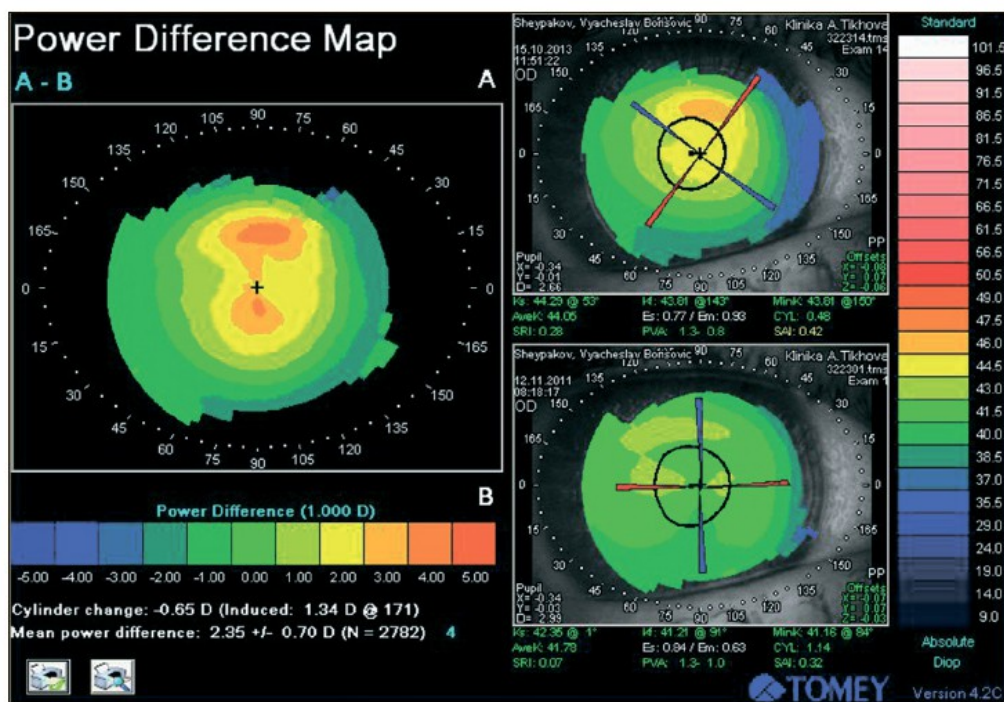


Рис. 2. Авторефрактометрия пациента III.

Conclusion

The postoperative results obtained by the domestic solid-state laser system "OLIMP -2000/213 -300Hz" are stable, predictable, safe, effective and comparable to the published clinical results of modern excimer laser systems of domestic and foreign production. Specific properties of solid-state lasers with a wavelength of 213 nm provide the technical and operational advantages of this technology over the excimer. Significantly simplify maintenance and reduce the cost of the operation.

Literature:

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