Tikhov A.V., Suslova A.Yu., Barysheva Zh.V., Suslov S.I., Tikhov A.O.

Correction of induced high degree hypermetropia on a solid-state refractive laser system "OLIMP-2000/213" (clinical case)

To date, laser refractive surgery is the leader among modern methods of correction of ametropia. But, unfortunately, the possibilities of this method are not limited. First of all, it concerns high degrees of hypermetropia and astigmatism.

Thus, in most guidelines on refractive surgery [1-3], as well as in the recommendations of manufacturers of excimer laser systems, indications for the correction of hypermetropic refraction are limited to 4-7 D, for the correction of astigmatism - 4 D. This is due to the anatomical and histological features of the structure of the cornea. Also, the reactivity of the corneal tissue and its ability to regenerate in response to an operating trauma [2]. It is well known that the intensity of the regenerative response in the form of a subepithelial fleur and the tendency to regress after surger ablation operations tend to increase in proportion to the degree of ametropia.

Such limitations do not allow the correction of induced hypermetropia or hypermetropic astigmatism to patients who had performed an operation of anterior radial keratotomy many years ago. In such situations, surface ablation techniques may be fraught with the development of a regression of the refractive effect in combination with a corneal flare of varying degrees of severity. Operations of laser keratomileusis in situ (LASIK) can be complicated by intraoperative problems with flap, as well as the appearance of diastase of postkeratomatous scars, especially if there are more than 8-10 incisions.

About 10 years ago, along with successfully operating excimer lasers, a new solid-state technology appeared in the arsenal of surgeons [2, 4-6, 9, 10]. Which allowed to expand the possibilities of refractive surgery, especially to ametropies of high degrees and complex refraction types.

An important feature of this technology is the phenomenon of "wet ablation". It is determined by the physical properties of ultraviolet radiation with wavelength (λ) of 213 nm: the radiation tolerance to the degree of hydration of the cornea makes it possible to effectively ablate the stroma of the cornea without drying, in the most physiological state [4, 5, 7, 8]. This phenomenon, as well as a lower energy and thermal load on the cornea when working on a solid-state laser (in comparison with the excimer laser), together have a less traumatic effect [4], and consequently, a smaller reactive response of the cornea to laser exposure.

Goal

To evaluate the possibilities of solid-state laser technology on the example of correction of induced hypermetropia of high degree.

Material and methods.

Patient V., born in 1980, turned to the clinic with complaints about the low visual acuity of both eyes. From the anamnesis: in 1999, an operation of anterior radial keratotomy for a high degree of myopia with astigmatism on the right eye, and midle degree of myopia with astigmatism on the left eye was performed on the basis of the mobile module MNTK "Eye Microsurgery". Over the past few years, there has been a significant decrease in vision at a distance and at close range; glasses and contact correction does not tolerate.

To solve the problem of the possibility of performing a laser correction surgery and choosing a surgical technique, a standard examination was performed: autorefractokeratometry (with a narrow pupil and under conditions of cycloplegia), visometry, keratotopography, pachymetry, contactless tonometry, biomicroscopy, ophthalmobiomiscroscopy (Table 1).

Table 1. Results of preoperative examination

Highlights	OD	OS
UCVA	0.1	0.2
Subjective refraction, D	sph + 10,0 cyl-4,25 ax73	sph + 3,5 cyl-3,0 ax81
BCVA	0.7	0.7
Autorefractometry in cycloplegia, D	sph + 9,0 cyl-3,25 ax68	sph + 3,25 cyl-3,25 ax82
Keratometry	failed	Rave 39,62D cyl-3,25 ax81
Keratotopography	R 32,31 cyl 2,70 ax 69	R 39,18 cyl 3,77 ax 90
Pachymetry in the center	552 microns	519 microns
IOP	Po 18.1 mmHg	12.3 mmHg
Biomicroscopy	10 radial and 2 tangential corneal scars	4 radial and 2 tangential corneal scars
The nature of the view	simultaneous	

When choosing the method of surgery, we were guided, first of all, by the state of the cornea. The presence of 12 after keratotomical scars did not allow us to choose the LASIK method. An alternative method that allows us to obtain stable satisfactory results and expand indications for refractive surgery is our photorefractive keratectomy technique with additional treatment of the ablated surface with 0.02% Mitomycin-C solution (MAGEK).

In the arsenal of our clinic surgeons, at the time of the operation, there were two domestic laser system: excimer (λ = 193 nm) and solid state (λ = 213 nm). A comparative analysis of the postoperative results obtained by that time determined our choice regarding the setting for surgery on the right eye with a more complex form of ametropia in favor of solid-state technology.

Thus, in both eyes, surgery was performed using the MAGEK method. The right eye was operated on the solid-state system "OLIMP-2000/213", the left one - on the excimer "OLIMP-2000/193" (Tables 2, 3).

The observation period was 3 years. In the postoperative period, no complications were noted. Medical therapy in the early postoperative period included instillations of anti-

inflammatory and antibacterial drops, after removal of soft contact lenses - instillation of corticosteroids in a descending scheme under the control of the IOP level. Complete re-epithelialization of the cornea of both eyes was observed on the 3rd day; The protective soft contakt lenses was taken on the 6th day. Three years after the operation, both eyes visual acuity and basic refractive indices were similar to those obtained one year after the operation (Table 4, Figures 1, 2).

Figure 1. Keratotopography OD: a) before surgery, b) 3 year after surgery

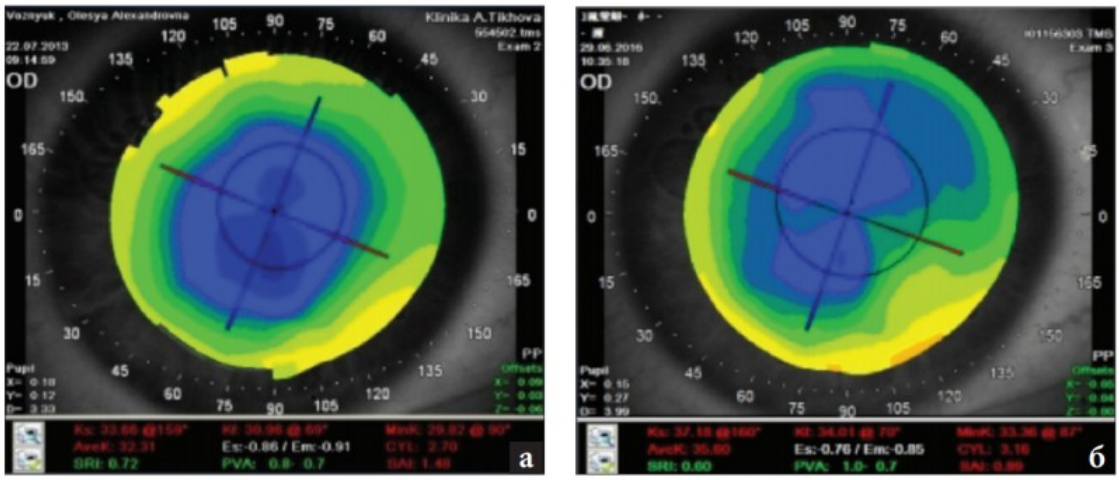

Рис. 1. *Кератотопограммы правого глаза: а) до операции; б) 3 года после операции*

Figure 2. Keratotopography OS: a) before surgery, b) 3 year after surgery

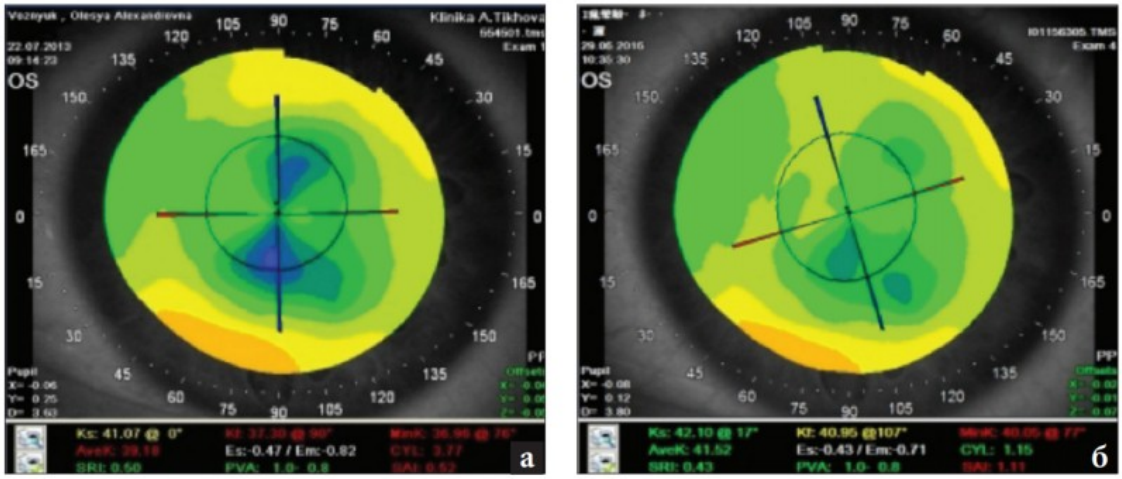

Рис. 2. *Кератотопограммы левого глаза: а) до операции; б) 3 года после операции*

Based on the results of a dynamic three-year follow-up period, it can be concluded that regression of the refractive effect is absent in both eyes, the obtained refractive results are stable and provide high uncorrected visual acuity exceeding by one line the most corrected visual acuity before the operation; biomicroscopically throughout the observation period the cornea remains transparent, subepithelial fibroplasia (Haze) is absent.

The patient is satisfied with the result of the operation. subjectively notes a significant increase in visual acuity at a distance and at a close distance and, as a result, a significant improvement in the quality of life.

Table 2. Technical characteristics of refractive system "OLIMP-2000/213" and "OLIMP-2000/193"

Specifications	Solid-state installation (λ = 213 nm)	Excimer installation (λ = 193 nm)
Wavelength	213 nm	193 nm
Generation frequency	100 Hz	100 Hz
The pulse energy	0.9 mJ	1.5 mJ
Diameter of spot	0,7 mm	0,8 mm
Forming system	Scanning spot	Scanning spot
Eye tracking	active, with a capture on the limb	active, with a grip on the pupil

Table 3. Operating protocol data

Basic parameters	OD	OS
Diameter of the optical / transition zone	5.8 / 7.8 mm	5.8 / 7.8 mm
Ablation depth	145.4 µm	80.27 µm
Exposure time	74 sec	34 sec
Expected calcification refraction of the cornea	38.8 D	42.58 D

Table 4. Postoperative follow-up data

Main factors	OD			OS		
	1 month	6 months	1 year	1 month	6 months	1 year
UCVA	0,6	0,7	0,8	0,6	0,8	0,8
Autorefractometry						
sph	+0.75	+1.75	+2.25	-1.5	-0.5	-0.25
cyl	-0.75	-1.25	-1.5	-0.75	-0.75	-1.0
ax	141	118	115	180	122	126
Keratometry						
Rave	37.0	36.25	36.25	42.0	41.0	41.25
cyl	-0.5	-1.75	-1.25	-0.75	-1.0	-0.75
ax	46	74	76	57	89	94
Haze	0	0	0	0	0	0
Pachimetry in the center			470 microns			506 microns
IOP, Ro	18	15	10	18	14	11

The conclusion.

This clinical case demonstrates the effectiveness of the solid-state refractive system "OLIMP-2000/213" in the correction of high degree hypermetropia.

Solid-state technology using radiation with λ = 213 nm, allows to expand indications to refractive operations, in particular, in cases of induced hypermetropia of "super-high" degree in combination with astigmatism.

Literature:

1. Balashevich L.I. Refractive surgery. - SPb .: Publishing house SPbMAPO, 2002. - 288 p.

2. Balashevich L.I. Surgical correction of abnormalities of refraction and accommodation. - St. Petersburg: Man, 2009. - 296 with.

3. Kurenkov V.V. Guide to excimer laser surgery. - Moscow: Publishing House of RAMS, 2002. - 400 p.

4. Tikhov A.V., Suslova A.Yu., Suslov S.I., Strakhova G.Yu. Application of solid-state lasers in the ultraviolet range in refractive surgery of the cornea. Review of the literature // Refractive surgery and ophthalmology. - 2010. - T. 10 (№ 3). - P. 11-15.

5. Tikhov A.V., Kuznetsov D.V., Suslova A.Yu., Strakhova G.Yu., Suslov S.I. The first domestic solid-state laser system for refractive surgery "Olimp-2000" // Congress of ophthalmologists of Russia, 9th: Tez. doc. - M., 2010. - P. 101.

6. Anderson I., Sanders D. R., Van Saarloos P. P., Ardrey W.J. IV. Treatment of irregular astigmatism with a 213 nm solid-state, diode-pumped neodymium: YAG ablative laser // J. Cataract. Refract. Surg. - 2004. - Vol. 30. P. 2145-2151.

7. Dair G.T., Ashman R.A., Eikelboom R.H. et al. Absorption of 193 and 213 nm laser wavelengths in sodium chloride solution and balanced salt solution // Arch. Ophthalmol. - 2001. - Vol. 119.-P. 533-537.

8. Hale, G. M., Querry, M.R. Optical constans of water in the 200 nm to 200 µm wavelength region, Appl. Opom. - 1973. - Vol. 12. - P. 555-563.

9. Tsiklis N.S., Kymionis G.D., Kounis G.A. et al. One-year results of photorefractive keratectomy and laser in situ keratomileusis for myopia using a 213 nm wavelength solid-state laser // J. Cataract. Refract. Surg. - 2007. - Vol. 33. - P. 971-977.

10. Tsiklis N.S., Kymionis G.D., Kounis G.A. et al. Photorefractive keratectomy using a solid state laser 213 nm and excimer laser 193 nm: a randomized, contralateral, comparative, experimental study // Invest. Ophthalmol. Vis. Sci. - 2008. - Vol. 49, No. 4. - P. 1415-1420.