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EFFECTIVENESS OF LASER VISION CORRECTION FOR MYOPIA AND ITS PREDICTORS

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The purpose of the study was to evaluate the effectiveness of laser vision correction for myopia depending on the demographic and clinical profile of patients in order to identify predictors of surgical outcomes. A total of 54 patients with myopia were observed, with an average age of 29.6±0.5 years. Vision correction was performed on 108 eyes using an excimer laser. All patients underwent topographic examination before the surgery and again three months postoperatively. The assessment of safety, predictability, and effectiveness of laser vision correction for myopia based on various criteria leads to consistent conclusions. Three months after laser vision correction, stable treatment outcomes were established: safety – 92.6±2.5 %, predictability – 88.0±0.1 %, effectiveness – 92.6±2.5 %, and stability – 92.6±2.5 %. The results of laser vision correction for myopia depend on the severity of myopia, the patient's age, preoperative visual acuity, and keratotopographic parameters (ISV, IVA, df, db, RPI, ART, RMS).

Key words: effectiveness, laser correction, myopia, predictor, vision.

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ЕФЕКТИВНІСТЬ ЛАЗЕРНОЇ КОРЕКЦІЇ ЗОРУ ПРИ КОРОТКОЗОРОСТІ ТА ЇЇ ПРЕДИКТОРИ

Метою дослідження була оцінка ефективності лазерної корекції зору при короткозорості залежно від демографічного та клінічного профілю пацієнтів для обґрунтування предикторів результатів операції. Під наглядом перебували 54 пацієнти із середнім віком 29,6±0,5 років із міопією. Корекцію зору проводили на 108 очах за допомогою ексимерного лазера. Усім пацієнтам було проведено топографічне обстеження до і після (на третій місяць) операції. Оцінка безпеки, передбачуваності та ефективності лазерної корекції зору за міопії з різними критеріями дають змогу дійти до подібних висновків. Через 3 місяці після лазерної корекції зору формуються стійкі результати лікування: безпека 92,6±2,5 %; передбачуваність – 88,0±0,1 %; ефективність – 92,6±2,5 %, стабільність – 92,6±2,5 %. Результати лазерної корекції зору міопії залежать від тяжкості міопії, віку пацієнта, гостроти зору операції та від кератотопографічних показників (ISV, IVA, df, db, RPI, ART, RMS).

Ключові слова: ефективність, лазерна корекція, короткозорість, предиктор, зір.

Myopia is a widespread pathology that significantly reduces the quality of vision. Modern refractive surgery capabilities, primarily due to the successful use of photorefractive keratectomy (PRK) and femtosecond laser keratomileusis (FS-LASIK), significantly improve the quality of vision in young people [2, 3, 5, 8].

The results of laser correction are evaluated by various criteria [1, 5, 10, 11]. The criteria of visual stability, predictability, and safety of correction effectiveness are most often applied [7, 10, 14]. It is noted that the predictability of spherical equivalent correction (SE±0.5D) is 91 % in single-stage transepithelial photorefractive keratectomy. At the same time, the equivalent efficacy and safety indices (1.13±0.16 and 1.15±0.12) were similar to those in patients after epipolis laser keratomileusis in situ [12]. Correction of myopia and myopic astigmatism by the FS-LASZK method, according to Czech researchers, is a highly effective, relatively safe and predictable method [8]. A comparison of refractive results after transepithelial photorefractive keratectomy and combined phototherapeutic keratectomy has shown the similarity of predictability, effectiveness and safety of operations [9]. According to these criteria, the effects of various optical zones during the extraction of a small-sized lenticle (SMILE) in patients with low and moderate myopia were evaluated [13].

Obviously, despite the long period of application of laser correction of myopia, the relevance of studying the effectiveness of this operation remains.

The purpose of the study was to evaluate the effectiveness of laser vision correction in myopia, depending on the demographic and clinical profile of patients, to substantiate predictors of surgical outcomes.

Materials and methods. Under supervision at the National Ophthalmological Center named after Academician Z. Aliyeva in 2024, there were 54 patients aged 20–39 years (average age 29.6±0.5 years) with myopia. Vision correction was performed on 108 eyes using the Navelight Allegretto EX 500 excimer laser (Alcon, Germany), power 500 HZ, spot diameter 680 microns. All patients underwent topographic examination before and after surgery (in the third month) using the Wavelight Allegro Topolyzer (Alson, Germany), Pentacam HR, and the Wavelight Oculyzer.

The information collected included: patient's gender and age, keratometry, indices of surface dispersion (ISV), vertical asymmetry (IVA), height asymmetry (IHA), height decentration (IHD), pachymetric progression (PPI), maximum relational thickness of Ambrosia (ART_{max}), total deviation from normality (BAD-D), total aberration of the highest order (RMS HOA), deviation from the normal anterior and posterior elevation (Df, Db), visual acuity with and without maximum correction (VAcc and VAsc) central thickness of the cornea, etc. According to all the noted quantitative parameters, a central distribution was carried out and two groups of patients were formed. One group included patients with values of these indicators less than their median, and the other group included patients with values greater than the median.

Table 1

Demographic and clinical profile of patients with myopia before laser vision correction

Signs	Variants of signs	Fraction, %	Signs	Variants of signs	Fraction, %
Gender	male	51.9±4.8	RPI_{avg}	<0.9	50.0±4.8
	female	48.1±4.8		>0.9	50.0±4.8
Age, years	20–30	43.5±4.7	ART_{avg}	≤552	55.5±4.8
	30–40	56.5±4.7		≥553	44.5±4.8
Severity of myopia	3.25–6.0	37.0±4.6	ART_{max}	≤445	53.7±4.8
	>6.25	63.0–4.6		≥446	46.3±4.8
Visual acuity without correction of the right eye	≤0.04	31.5±4.5	BAD.D.	≤0.95	45.4±4.8
	0.05–0.9	37.0±4.6		≥0.96	54.6±4.8
	0.1–0.2	31.5±4.5	RMS_{total}	≤1.65	47.2±4.8
Visual acuity without left eye correction	≤0.04	18.5±3.7		≥1.66	52.8±4.8
	0.05–0.09	50.0±4.8	RMS HOA	≤0.33	45.4±4.8
	0.1–0.2	31.5±4.5		≥0.34	54.6±4.8
Visual acuity of the right eye with maximum correction	0.3–0.7	25.0±4.2	Safety	all	92.6±2.5
	0.8–1.0	75.0±4.2			
Visual acuity of the left eye with maximum correction.	0.3–0.7	25.9±4.2	Predictability	all	88.0±3.1
	0.7–1.0	74.1±4.2			
Keratometry	<43.5	46.3±4.8	Effectiveness	all	92.6±2.5
	>43.5	53.7±4.8			
Maximum elevation of the posterior corneal wall	<8.5	44.4±4.8			
	>8.5	55.6±4.8	Stability	all	92.6±2.5
Maximum elevation of the anterior corneal wall	<15.0	48.1±4.8			
	>15.0	51.9±4.8	Safety average value	all	0.93±0.01
ISU	<16	63.9±4.6			
	>16	36.1±4.6			
IVA	<0.1	36.1±4.6	Predictabilityaverage value	all	78.1±1.9
	>0.1	63.9±4.6			
IHA	<4	54.6±4.8	Efficiency is an average value	all	0.89±0.01
	>4	45.4±4.8			
IHD	<0.007	36.1±4.6			
	>0.007	63.9±4.6			
The central thickness of the cornea	486–551	54.6±4.8			
	552–605	45.4±4.8			
RPI_{max}	<1.2	45.4±4.8			
	>1.2	54.6±4.8			

The results of laser correction were evaluated at the end of the third month after surgery. The main criteria for the outcome of the operation were stability (St), safety (S), predictability (P) and the effectiveness of correction(E) [2]:

St=(N-Np)×100/N, where N is the total number of eyes operated on, Np is the number of eyes with a regression of the planned refractive effect by more than 0.5 D;

S=(N-Nv)×100/N, where Nv is the number of eyes in which the maximally corrected visual acuity decreased or increased.;

$P=(N-N_2)\times100/N$, where N_2 is the number of eyes whose postoperative refraction differed from the planned one by more than 0.5 D;

E=(N-Ne)×100/N, where Ne is the number of eyes in which postoperative visual acuity without correction was less by 2 or more lines than the maximum corrected one before surgery.

At the same time, the correction results were evaluated according to the criteria of English-speaking scientists [2]:

Safety = postoperative VAcc /preoperative VAcc;

Predictability = expected spherical equivalent – achieved spherical equivalent. The predictability value is the percentage of an eye with a spherical equivalent of ±1 D.

Efficiency = postoperative VAsc /preoperative VAcc [2].

The calculation of the relative risk of safety, stability, predictability and efficiency of the operation was carried out according to the formula:

Relative risk (RR) = $\frac{a}{a+b} : \frac{c}{c+d}$

The standard error (S) = $\sqrt{((1-\frac{a}{a+b}):a) + ((1-\frac{c}{c+d}):c))}$

The results of laser correction were calculated for all groups of patients, formed by the values of the median (<and>) of the topographic parameters of the cornea. The difference between these groups in terms of operation performance was assessed by criterion χ^2. The critical value of the statistical significance of the difference is 0.05.

Results of the study and their discussion. The demographic and clinical characteristics of patients with myopia before surgery and the main performance indicators of the operation are shown in Table 2. The proportion of men and women among patients converges (51.9±4.8 and 48.1 %; p>0.05). The proportion of people aged 30–40 years prevailed in the age group of patients (56.5±4.7 %; p=0.05). The proportion of patients with severe myopia (>6D) was also significantly higher than the proportion of those with moderate myopia (63.0±4.6 % and 37.0±4.6 %, respectively; p=0.01). The distribution of patients according to visual acuity (VAsc) of the right and left eyes differs from each other in the proportion of individuals with an index of ≤0.04 (31.5±4.5 and 18.5±3.7 %; p<0.05) and 0.05–0.09 (37.0±4.6 and 50.0±4.8 %; p<0.05). The distribution of patients according to the size of the right and left eye VAcc (Table 1) is similar.

Table 2

Results of laser correction of myopia depending on the demographic and clinical profile of patients

Signs	Variants of signs	Security %	Predictability %	Effectiveness %	Stability	P
Severity of myopia	<6.0D	97.5±2.5	95.0±3.4•	97.5±2.5	100•	P_n=0.05 P_c=0.01
	>6.25 D	89.7±3.7	83.8±4.5	89.7±3.6	88.2±3.7	
Age, years	20–30	85.1±5.1	85.1±5.1	87.2±4.8	82.9±5.5	$P_б$=0.05 P_s=0.01
	30–40	98.4±1.6•	90.2±3.8	96.7±2.3	100.0•	
VAsc before surgery	<0.04	85.3±6.1	79.4±6.9	82.3±6.5	79.4±6.5	P_n=0.05 P_e=0.05 P_c=0.01
	≥0.1	97.1±2.9	97.1±2.9•	97.1±2.9•	97.5±2.5•	
ISV before surgery	<16	97.1±2.0•	91.3±3.4	95.0±2.4	100•	$P_б$=0.05 P_c=0.01
	>16	84.6±5.7	82.1±6.1	87.1±5.3	79.5±6.4	
IVA before surgery	<0.1	97.4±2.5	94.9±3.5	97.4±2.5	100.0•	P_c=0.01
	>0.1	89.8±3.6	84.1±4.4	89.9±3.6	88.4±3.8	
IHA before surgery	<4	96.6±2.4	93.2±3.2	98.3±1.6•	96.6±2.3	$P_э$=0.05
	>4	87.4±4.6	81.6±5.5	85.7±4.9	87.7±4.6	
Keratometry	<41D	96.0±2.7	92.0±3.8	98.0±1.9•	94.0±3.3	P_e=0.05
	>41 D	89.6±3.9	84.4±4.7	87.9±4.2	91.3±3.6	
Df	<8	97.9±2.0•	95.8±2.8•	97.9±2.0•	95.8±2.8	P_e=0.05 $P_б$=0.05
	>8	88.3±4.1	81.6±4.9	88.3±4.1	90.0±3.8	P_n=0.01
Db	<15	98.1±1.9	96.1±2.6	100	98.1±1.9	$P_б$=0.05 P_n=0.01 P_e=0.01 P_c=0.05
	>15	87.5±4.4	80.3±53	85.7±4.6	87.5±4.4	
PPI_{max}	<1.2	98.0±2.0•	93.9±3.4	95.9±2.8	97.9±2.0•	$P_б$=0.05 P_e=0.05
	>1.2	88.1±4.2	83.0±4.8	89.8±3.9	88.1±4.2	
PPI_{avg}	<0.9	96.3±2.5	94.4±3.1•	98.1±1.8•	100 •	P_n=0.05 P_e=0.05 P_c=0.01
	>0.9	88.8±4.2	81.4±5.2	87.0±4.5	85.1±4.8	
ART_{max}	≤445	98.3±1.7•	94.8±2.9•	96.5±2.4	100 •	$P_б$=0.05 P_n=0.05 P_c=0.01
	≥446	86.0±4.9	80.0±15.6	88.9±4.5	84.0±5.1	
RMS_{total}	<1.65	96.1±2.7	90.2±4.1	98.0±1.9•	94.1±3.2	P_e=0.05
	>1.65	89.4±4.1	85.9±4.6	87.7±4.3	91.2±3.7	

The median of the main keratotopographic measurements was 43.5D for cartometry, 8.5 for the maximum elevation of the anterior and 15 for the posterior corneal wall (df u db), +6 for ISV, <0.1 for IVA, 4 for IHA, 0.007 for IHD, 551 for the central thickness of the cornea, 1.2 for RPI_{max}, 0.9 for RPI_{avg}, 445 for ART_{max}, 552 for ART_{avg}, 0.95 for BAD.D and 0.33 for RMSHOA.

The level of indicators of the result of laser correction three months after surgery, calculated according to the methodological recommendations of scientists, was high and amounted to 92.6±2.5 % for safety, 88.0±3.1 % for predictability, 92.6±2.5 % for both effectiveness and stability. These indicators in

the groups of patients formed by demographic and clinical characteristics (gender, age, median topographic parameters of the cornea) did not differ statistically significantly from each other, statistically significant ($p \leq 0.05$) differences were in a number of criteria in individual groups (Table 2). It is obvious that the results of laser correction are significantly influenced ($p \leq 0.05$) by the severity of myopia, the patient's age, VAsc, ISV, IVA, IHA, keratometry, Df, Db, PPImax, PPI_{avg}, ART_{max}, RMS_{total} before surgery.

The results of laser correction are characterized by a high level of safety (≥84.6±5.7 %), predictability (≥79.4±6.9 %), effectiveness (≥82.3±6.5 %) and stability (≥79.4±6.5 %), which vary depending on the demographic and clinical profile of patients.

The results of laser correction 3 months after surgery are presented in the work of Chinese and English scientists [6], which confirms a positive outcome. Our work also confirms that 3 months after laser correction, there is a steady improvement in optical results. According to our data and data from Castro-Luna G. The safety (0.93±0.01 and 0.88±0.28), predictability (78.1±1.9 and 80.9 %), and effectiveness (0.89±0.1 and 0.83±0.29) of laser correction of myopia were similar [2].

Our data on the results of laser vision correction in myopia are also similar to the reports of other authors [2]: safety 92.6±2.5 and 94.4 %; predictability 88.0±3.1 and 82.2 %; effectiveness 92.6±2.5 and 91.1 %; stability 92.6±2.5 and 88.9 %. Similar data on the result of laser correction are given in the works of a number of researchers [4, 10, 11]. The dependence of safety, predictability, effectiveness and stability in laser correction of myopia on the demographic and clinical profile of patients is shown in our work. We believe that the demographic and clinical characteristics of patients can be studied as predictors of the results of laser correction.

Conclusions

1. The assessment of the safety, predictability and effectiveness of laser vision correction in myopia by different criteria allows us to reach similar conclusions. The results of laser correction are characterized by a high level of safety (≥84.6±5.7 %), predictability (≥79.4±6.9 %), effectiveness (≥82.3±6.5 %) and stability (≥79.4±6.5 %), which vary depending on the demographic and clinical profile of patients.

2. 3 months after laser vision correction, stable treatment results are formed: safety 92.6±2.5 %; predictability – 88.0±0.1 %; effectiveness – 92.6±2.5 %, stability – 92.6±2.5 %.

3. The results of laser correction of myopia vision depend on the severity of myopia, the patient's age, the visual acuity of the operation, and on keratotopographic parameters (ISV, IVA, df, db, RPI, ART, RMS). The predictability of laser correction results is higher in the group of people aged 30–40 years (90.2±3.8 %) than in those aged 20–30 years (85.1+5.1 %).

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