FUNCTIONAL RESULTS OF CONTACT LENS CORRECTION AND PENETRATING KERATOPLASTY IN KERATOCONUS. Report 1. ANALYSIS OF RESOLUTION ABILITY OF THE EYE

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Comparative analysis of functional results of contact lens correction and penetrating keratoplasty (PKP) in keratoconus is presented. To assess resolution ability we examined visual acuity and contrast sensitivity. 117 patients (219 eyes) with stage IV keratoconus, wearing rigid gas-permeable lenses (RPCL), and 60 patients (64 eyes) after PKP were investigated. In 69% after PKP non-corrected visual acuity (NCVA) was 0,1 or more and its mean was 0,63, that is similar to efficacy of contact lens correction in stage III-IV keratoconus. In 31%, NCVA after PKP was less than 0,1 due to significant refractive disturbances. These patients required the use of RPCL or refractive surgery for their visual rehabilitation. Contrast sensitivity in medium frequencies after PKP was almost similar to that of contact lens correction in stage III keratoconus, and in high frequencies, it was close to that of stage IV.

Keywords: keratoconus, rigid gas-permeable contact lenses, penetrating keratoplasty, visual acuity, contrast sensitivity

Vestnik Oftal'mologii 2011; 5: 3-6

Keratoconus is a noninflammatory progressing dystrophic corneal disease. Pathologic corneal changes lead to the irregular corneal surface and as a consequence to the irregular corneal astigmatism due to which the correction by spectacles is little effective. An optimal method of the optical correction in keratoconus are hard gas-permeable contact lenses which allow to restore the anterior corneal surface sphere , compensate irregular astigmatism and achieve high functional results [1, 3—5, 7, 12, 14, 15]. As the disease progresses, irreversible changes arise in all corneal layers, which lead to diminished corneal transparency and optical homogeneity [2]. Morphological disturbances result in occurrence of opaque corneal zones that is followed by gradual decrease of visual acuity, when hard contact lens correction is being used [4]. Significant epeithelial changes are revealed during corneal growing pathological alterations< with epitheliocyte morphology disturbance, decrease of epeithelial cell adhesion in the superficial layer, and emergence of defects in cellular layers. The phenomenon of epitheliopathy and impossibility of adequate HGCL selection in pronounced corneal deformation are important factors, causing the decrease of contact lens tolerance.

When function results of contact lens correction and their tolerance diminish, the question of surgical treatment must be considered. A penetrating corneal transplantation is most commonly used surgical interference in keratoconus. However, functional results of this surgical treatment are variable and depend on several causes (initial corneal condition, an operation technique, healing peculiarities, possible complications) [5, 9—11, 15].

Secondary ametropia is the most frequent cause of visual function decrease after the penetrating keratoplasty (PKP)/ In a number of cases, high postoperational astigmatism occurs, and correction by spectacles is not sufficiently effective, and intolerable. In such cases, prescribing of HGCL or excimer laser interference is required [4, 6, 8]. Optical aberrations both of the lower order (defocus and astigmatism) and the high one, can influence the vision quality, the degree of aberration being dependent on graft condition and corneal surface regularity. To some extent, visual quality can be judged by correlation of contrast sensitivity indices [3, 4, 13].

Thus considering the advisability of PKP in certain clinical conditions it is necessary to take into account both functional possibilities of optical HGCL correction and potential operation results.

The purpose of this work is a comparative analysis of eye resolution ability in correction by HGCL and PKP in keratoconus.

Material and methods

Two groups of patients were studied. The first group included 117 patients (219 eyes) with stage I-IV keratoconus. Stage I keratoconus was diagnosed in 49 cases, II— in 57, III— in 54, and IV— in 59. The participants' age ranged from 14 to 65 years. Suitable HGCL were chosen to all the patients. The studies were conducted after successful adaptation to the contact lenses with visual and subjective comfort.

In the second group, the functional results of 64 PKP operations (60 patients, 64 eyes) were analyzed.

To assess resolution ability a traditional visometry and visocontrastmetry were used. Besides, the level and the structure of refractive disturbences as one of the ma-

jor causes of possible visual acuity decrease were analyzed.

The maximum visual acuity was assessed in the process of visometry. Autorefractometry was performed using OPD Scan (NIDEK, Japan). A computer topograph CT-1000 (Chin0Nippon, Japan) was used for the corneal topography. Visocontrastmetry was performed with computer programme "Zebra@. Spatial stimulus frequency was measured by number of cycles per a degree. A curve characterizing a spatial sensitivity was by the results of the patients' answers. The contrast sensitivity level was estimated in decibels (dB).

Statistical analysis was performed Microsoft Office Excel programme 2007.

The average meanings or median were used for the characteristic of the central tendency (the most typical meanings in the sample depending on the distribution type of the sample.

The mean values were determined for the normally distributed data of statistical sample. Standard deviation values were used to assess the dispersion characterizing the degree difference of each value from the average one. In cases of normal distribution, the mean value is the most effective characteristic.

The median as well as an average meaning characterizes the central tendency. However, in contrast to the average value the median is more reliably characterizes asymmetric distribution since the data that considerably differ from typical data of the sample do not influence value meanings.

Results and discussion

The visual acuity data in HGCL correction in dependence on keratoconus stage are given in **Table 1**.

In analysis of the PKP results the patients were conventionally divided in two subgroups.

Twenty patients (20 eyes) with postoperative uncorrected visual acuity below 0.1 (mean 0.045±0.026) were included in the first subgroup. After correction by spectacles, visual acuity was 0.38±0.2. However, correction by spectacles, as a rule, was intolerable due to a high level of both spherical (mean 6.0±3.6 dptr) and cylindrical (mean 4.6±2.5 dptr) correction components. The corneal astigmatism in the central zone, as revealed computer videokeratography varied from 2.5 to 8.0 dptr (mean 5.21±3.39); there were signs of corneal surface irregularity.

40 patients (44 eyes) with uncorrected visual acuity above 0.1 (mean 0.38±0.27) were included in the second subgroup; the tolerable spectacle correction provided increase of this value mean till 0.63±0.21. Meanwhile, spherical and cylindrical components of the correction by spectacles were mean 2.8±2.06 and 3.5±2.64 dptr , respectively. The corneal astigmatism, as estimated by computer videokeratography was within 2.06— 6.0 dptr (mean 3.94±2.56 dptr).

Satisfactory functional PKP results obtained in the patients of the second subgroup were subsequently used for the comparative analysis of the contact correction by HGCL and PKP.

Average values of visual acuity in keratoconus of different stages with the correction by HGCL and those after PKP are represented in **Figure 1**.

The diagram analysis evidences that the average visual acuity values post-PKP in tolerable spectacle correction were below the average level of this index by 42.9 and 20.6% and vice versa, they were by 22.2% higher with the contact correction I, II and IV keratoconus stages. Statistically significant differences between the pointed visual acuity values were not noted in the contact correction of the III stage keratoconus.

Three frequency ranges were used for the contrast sensitivity estimation< and the data obtained were largely dispersed/ Thus in every frequency range comparison of indices variability was conducted using such statistic value as median as well as mean values characterizes the main tendency. Studies were performed with keratoconus correction by HGCL and post PKP with maximum spectacle correction for the distant sight **(Table 2)**.

Comparison of visocontrastmetry indices in low frequencies for different keratoconus stages, corrected

Table 1. Visual acuity (M±σ) in correction keratoconus of different stages by HGCL

Keratoconus stage	(M±σ)
I	0.90±0.16
II	0.76 ±0.14
III	0.67±0.19
IV	0.49 ±0.10

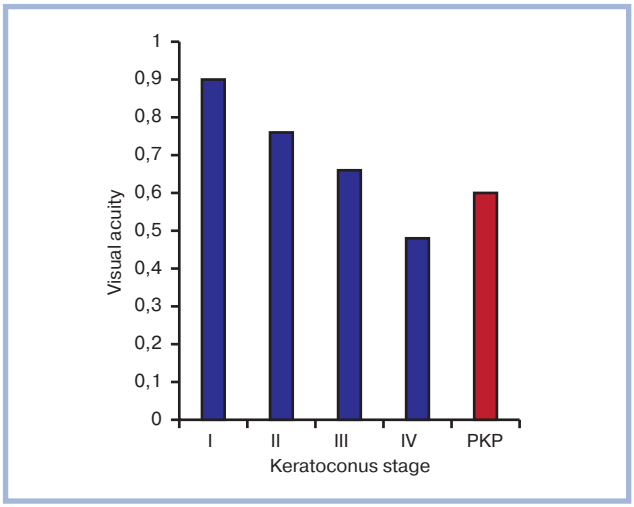

Fig. 1. **Mean visual acuity values in correction by HGCL and after PKP.**

Table 2. **Contrast sensitivity median in keratoconus correction by HGCL and after PKP.**

Frequencies	Contrast sensitivity median, dB				
	In keratoconus correction by HGCL				After PKP
	Stage I	Stage II	Stage III	Stage IV	
Low	31.0	29.75	29.5	30.0	30.0
Medium	40.5	38.75	36.5	34.0	37.0
High	21.6	19.0	17.5	11.0	14.4

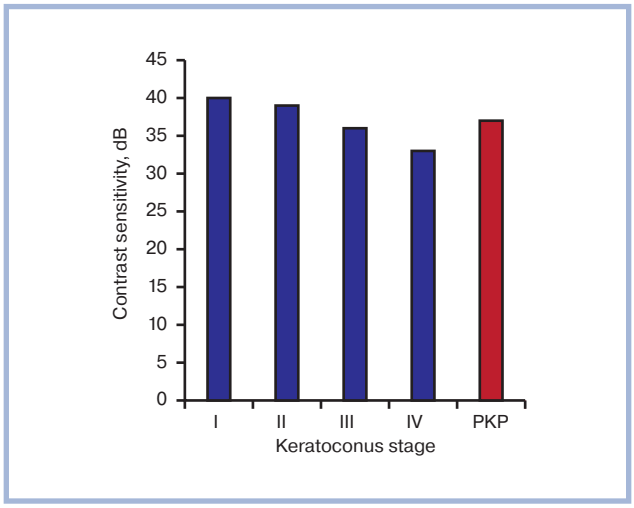

Fig. 2. **Contrast sensitivity median in medium frequencies with keratoconus correction by HGCL and after PKP.**

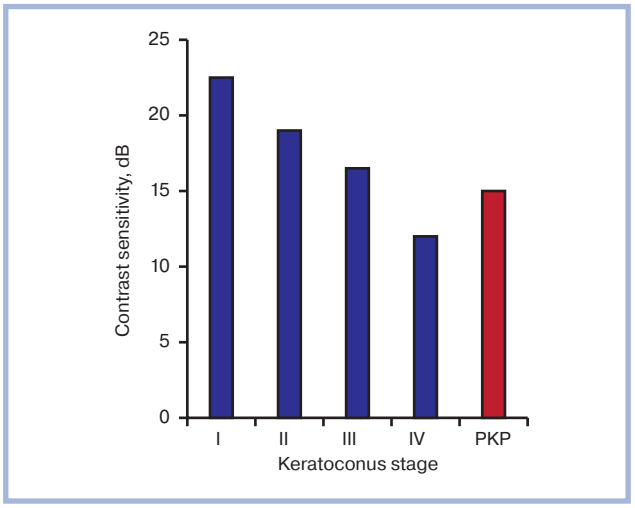

Fig. 3. **Contrast sensitivity in high frequencies with keratoconus correction by HGCL and after PKP.**

with HGCL and PKP results do not reveal any distinct differences.

A distinct gradual decrease in contrast sensitivity level with progressing of keratoconus was found in the medium frequencies **(Figure 2)**. In stages I and II, the indices in contact correction were higher than post PKP by 9.5 and 4.5. The median meanings in stage III keratoconus and those of postoperative interference were practically the same. The contrast sensitivity level with the contact correction in stage IV keratoconus, was by 8% below compared with PKP results.

The same tendency of gradual decrease in contrast sensitivity level with progressing of the pathologic process is seen in the range of high frequencies **(Figure 3)**. However, results in keratoconus HGCL correction in stages I, II and III exceed the data obtained after PKP (by 50, 32, 21, 5) At the same time, PKP provides the higher contrast sensitivity (by 23.7%) compared with the HGCL correction keratoconus IV stage.

Conclusion. The question about the transition from contract keratoconus correction to PKP remains to be disputable. In our opinion, one of the criteria must be potential functional result of the method application.

As our studies showed, in 31% of cases, uncorrected visual acuity post PKP does not exceed 0.1 due to essential refractive disturbances, therefore visual rehabilitation may require either HGCL correction or keratorefractive surgery.

In remained 695 of cases, uncorrected visual acuity post PKP is 0.1 and more, and with maximum spectacle correction is on the average 0.63 that corresponds to the values which are analogues to the indices in contact correction the stages III and IV keratoconus.

Frequency-contrast characteristics of the optic eye system are more refined criteria of eye resolution ability.

The contrast sensitivity level post PKP in the medium frequency range, is close to that of the analogous index in stage III keratoconus HGCL correction, and in the high frequency range it approaches to the indices in stage IV of the disease.

It is necessary take into account the obtained data in planning PKP in the early stages of keratoconus.

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