KERATOCONUS: CURRENT DIAGNOSTIC APPROACH

L.S. Pateyuk

M.M. Krasnov Research Institute of Eye Diseases, Moscow, Russia

ABSTRACT

Keratoconus is an ectatic corneal disease, resulting in loss of visual functions in young population. Diagnosis of the disease at a moderate stage with a typical progressive clinical course is not particularly difficult; however, the diagnosis verification in a few cases is rather troublesome. This literature review systematizes modern conceptions to the keratoconus diagnosis, outlines current approaches to patients examining and diagnostics results assessing. The clinical manifestations (complaints, anamnesis data, visometry and autorefractokeratometry results) at the early stages of keratoconus with its non-progressive course are similar to ordinary myopia and regular myopic astigmatism; as a result, it is quite difficult to suspect the disease in such cases. With progressive keratoconus course, as corneal protrusion develops, the disease acquires features specific for gradual irregular corneal myopic astigmatism growth. Currently valuable pathognomonic slit-lamp signs of keratoconus are Fleischer's ring, stromal Vogt's striae and focal thinning of the cornea in the ectasia apex. Nowadays the gold standard of keratoconus diagnosis and screening is comprehensive examination of the cornea by means of modern computer optical scanning (Scheimpflug camera in particular) keratoanalyzers, combining keratoscopy (Placido's disc) and keratotomography. The keratoanalyzers original software generates maps and calculates irregularity indices of the cornea shape (keratotopography), refractive power (keratometry) and thickness (keratopachimetry), as well as values the probability and stage of corneal protrusion. Such diagnostic platforms provide differential diagnosis and verification of keratoconus at the earliest signs of the topographic stage of the disease; to date, there are no effective methods, that can reliably confirm or exclude ultrastructural changes at the pretopographic stage of keratoconus.

Keywords: *Fleischer ring; corneal topography; slit lamp examination; classification; subclinical keratoconus.*

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INTRODUCTION

Keratoconus is a non-inflammatory ectatic disease of the cornea, having a degenerative-dystrophic origin and being associated with destructive changes in the corneal tissues. The disease manifests as progressive thinning and bulging (protrusion, ectasia) of the central part of the cornea, as a result of which, it gains a cone shape, which clinically manifests as a progressive irregular corneal myopic astigmatism with a decrease in the maximal (best) corrected (with using the corrective lenses) vision acuity (BCVA). The keratoconus is commonly believed as being a bilateral disease, due to which, in cases of detecting the signs of keratoconus in one eye, the other eye (in the absence of visible pathological changes in it) is considered a subclinical form (stage) of keratoectasia [1–5].

The diagnostics of keratoconus in its progressed stage and with typical clinical signs is not very difficult in the practice of an ophthalmologist. However, at the initial stages of the disease and in case of its non-progressive course, the process of verifying the diagnosis can be quite difficult. During the several decades of active research on the methods for diagnostics, treatment and correction of keratoconus, the terminology and the classification of this disease have undergone a number of significant evolutionary changes, while the criteria for managing the patients have been multiple times revised depending on the clinical tasks and the possibilities of practical medicine.

DIAGNOSTICS OF KERATOCONUS

The diagnostics of keratoconus is based on the disease history data, on the presence of some specific complaints, on detecting certain biomicroscopic symptoms and on the results of the visualization methods used to define the shape of the cornea (keratotopography), its refractive power (keratometry)

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СОВРЕМЕННЫЕ ПОДХОДЫ К ДИАГНОСТИКЕ КЕРАТОКОНУСА

Л.С. Патеюк

Научно-исследовательский институт глазных болезней имени М.М. Краснова, Москва, Россия

АННОТАЦИЯ

Кератоконус — эктатическое заболевание роговицы, наблюдаемое у лиц молодого и трудоспособного возраста, приводящее к утрате зрительных функций. Диагностика этого заболевания на развитой стадии и при типичном прогрессирующем клиническом течении не представляет особых затруднений, однако в ряде случаев верификация диагноза сопряжена с некоторыми сложностями. В обзоре систематизированы современные представления о диагностике кератоконуса, последовательно изложены актуальные подходы к обследованию пациентов и интерпретации результатов исследования. Клиническая картина (жалобы, данные анамнеза, результаты визометрии и авторефрактокератометрии) на начальных этапах развития кератоконуса и при не прогрессирующем его течении идентична ординарной миопии и регулярному миопическому астигматизму, вследствие чего заподозрить наличие заболевания достаточно сложно. При прогрессирующем кератоконусе по мере развития кератэктазии клиническая картина приобретает специфические для этого заболевания особенности, представляющие собой, по сути, прогредиентные проявления иррегулярного роговичного миопического астигматизма. К актуальным патогномоничным биомикроскопическим симптомам кератоконуса можно отнести пигментное кольцо Флейшера, стромальные стрии-полосы Фогта и фокальное истончение роговицы в области вершины экстазии. Золотым стандартом диагностики и скрининга кератоконуса в настоящее время считается комплексное исследование роговицы при помощи современных компьютерных оптических кератоанализаторов сканирующего типа (в том числе типа ротационной Шаймпфлюг-камеры), сочетающих в себе кератоскопию (диск Пласидо) и кератотомографию. Оригинальное программное обеспечение кератоанализаторов моделирует карты и рассчитывает индексы иррегулярности формы (кератотопография), преломляющей силы (кератометрия) и толщины (кератопахиметрия) роговицы, а также оценивает вероятность и стадию кератэктазии. Такие диагностические платформы позволяют проводить дифференциальную диагностику и верифицировать кератоконус при самых ранних проявлениях кератотопографической стадии заболевания, при этом эффективных методик, позволяющих достоверно подтвердить или исключить ультраструктурные изменения на прекератотопографической стадии кератоконуса, на сегодняшний день не существует.

Ключевые слова: *кольцо Флейшера; кератотопография; биомикроскопия; классификация; субклинический кератоконус.*

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and thickness (keratopachymetry). At the initial stages of keratoconus, one cannot always suspect the development of keratoectasia. As the disease progresses, more and more clear manifestations of specific symptoms and complaints, characteristic for keratoconus, can be observed. In case of non-progressive keratoconus, the patients can spend a long time under medical supervision by ophthalmologists with the diagnosis of myopia or myopic astigmatism. Due to wide spreading of modern high-tech computed corneal analyzers and of the keratorefractive surgical interventions performed for the purpose of correcting the ametropies, a considerable growth is observed in the rate of detecting keratoconus in the population of relatively healthy individuals.

The keratoconus patients can present with both non-specific and sufficiently specific complaints, in particular, complaints of progressive decreased vision acuity, often changing spectacles or contact lenses used for vision correction, difficulties when adjusting the optical correction (or impossibility of such adjustment), as well as unclear, blurred or clouded vision; complaints of visual deterioration (decreased clarity, presence of halo, glares, optic radiation, backlights and other optical light effects) in the twilight settings (with the pupil being dilated at twilight); complaints of variability

in the visometry results from one examination to another; monocular polyopia (diplopia, multi-image); photophobia; irritation of eyes expressed as dry eye symptoms or asthenopic signs [1, 3–10].

At the initial stages of keratoconus development, the complaints in the patients are, generally, identical to the ones in patients with myopia or regular myopic astigmatism, due to which suspecting the development of keratoconus is quite difficult.

When collecting the disease history data, attention should be paid to such characteristic features of the disease progression as the development of an acquired corneal myopic astigmatism or index myopia (due to progressive increase of the curvature and of the refractive capacity of the cornea) at the adult age (at the postpubertal period); progressing increase of the corneal myopic astigmatism or index myopia [1, 3–10].

The visometry results in patients with initial stages of keratoconus development are generally identical to those found in cases of ordinary refraction anomalies, such as myopia or regular myopic astigmatism. As the keratoconus progresses and as irregular corneal myopic astigmatism develops along with clinically significant corneal deformation, the following characteristic features appear:

- decreased BCVA when using spectacle lenses testing (incapability of achieving the retinal vision acuity);
- increased visometry results (BCVA elevates up to achieving the retinal vision acuity) in the settings of diaphragmation;
- increased visometry results (BCVA elevates up to achieving the retinal vision acuity) when using the testing with hard gas-permeable contact lens;
- "fluctuating" (from one examination to another, during the same ophthalmologist's appointment or when adjusting the spectacles) degree and axis of corneal astigmatism;
- the patient is trying to find a comfortable position for the head and eyes when viewing the optotypes [1, 3–10].

The refractometry results, as the disease progresses, become more typical for keratoconus with unstable refraction (after several consecutive measurements, or from one examination to another) and abnormally high astigmatism degree [1, 3–10].

The keratometry (ophthalmometry) parameters at the beginning of keratoconus development do not exceed the mean statistical reference ranges. As the disease progresses, the corneal curvature gradually increases: the curvature radius of the cornea and the keratometry parameters exceed the normal reference ranges. During the course of keratometry in keratoconus patients, the following characteristic signs of the disease can be noted:

- irregular (incorrect) corneal astigmatism;
- dislocation (dislocation and deformation) of marker reflexes (distortion-curving of the mires or asymmetry in four mutually perpendicular points); Fig. 1;
- abnormally high degree of refractive power of the cornea or corneal astigmatism [1,3–10].

Biomicroophthalmoscopy allows for visualizing the specific signs of keratoconus, generally, in cases of advanced stages of the disease. Biomicroscopic symptoms of keratoconus can be found when examining under various angles with various light intensity: when using direct focal illumination, indirect illumination (in the dark field) and reflected light, as well as when optical section illumination is used. In patients with initial stages of keratoconus, the examination with using the slit-lamp commonly does not allow for verifying the diagnosis. The specific biomicroscopic markers of keratoconus are the following:

- pigment ring (Fleischer's) — a sub-epithelial deposit of pigmented compound of chalcophylic metals (copper, zinc and iron), situated at the base of the ectasia, visualized as a closed ring or (more often) an arch (semicircle) in the lower segment of the cornea (Fig. 2, *a*);
- stromal striae (Vogt's) — the apical vertical stripes in the corneal stroma, developing due to the over-extension of stroma (see Fig. 2, *b*), most probably, represent cracks and folds in the posterior stroma of cornea and the folds of the Descemet's membrane in the apical area of the protrusion; they disappear upon compression applied to the cornea;
- "fading star" symptom, or "fireworks" — rarefaction of corneal stroma at the zone of the developing ectasia, visualized as the inhomogeneity in the cornea or grayish opalescence (see Fig. 2, *c*); arising from the impairment of the collagen plate architectonics in the anterior corneal stroma;
- focal thinning of the cornea at the apex of ectasia (apical protrusion) at the central or paracentral zone of the cornea;
- prominent lenticular stromal nerves of the cornea (see Fig. 2, *d*);
- turbidity and scars in the cornea at the apex of the protrusion, located at the level of the corneal epithelium, sub-epithelially and in the corneal stroma; arising as a result of swelling and fibrotic processes (cicatrization) in the corneal tissues due

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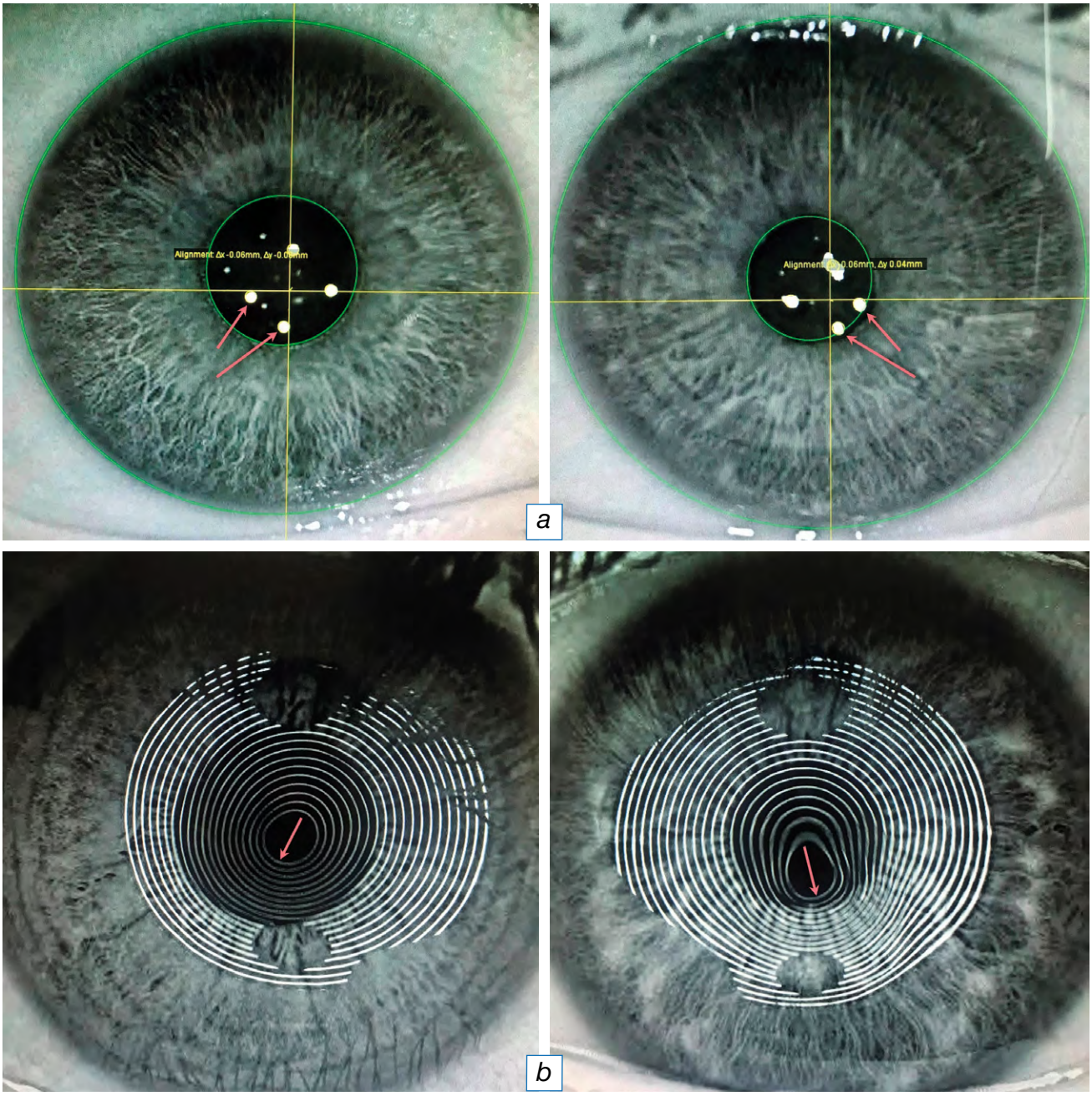

Fig. 1. Cornea anterior surface reflexes in keratoconus: *a* — autorefractokeratometry four dot marks displacement (red arrows indicate spot light reflexes shift adjacent to ectasia apex); *b* — Placido disk mires-rings distortion (red arrows indicate concentric light reflexes convergence adjacent to ectasia apex).

to rough abnormalities in the architectonics of the over-extended stroma, “cracks” (ruptures) in the Descemet’s membrane (with stromal swelling and corneal hydrops) and as a results of using the hard gas-permeable contact lens [1, 3–12].

Among the specific symptoms of keratoconus that have practically lost their clinical-diagnostic significance due to the high level of ophthalmology equipment development, the following are worth noting:

- Munson symptom — V-shaped profile of the lower eyelid margin when the patient is looking downwards;
- Rizzuti symptom — when illuminating with focused light in the frontal plane of the eyeball from the temporal side, a light reflex can be observed in the sclera from the nasal side as a result of pathological deflection of light towards the base of the cornea as a prism caused by impaired optical properties of the cornea;
- “scissor” symptom upon sciascopy, or “shadow whirling”, or “folding shadow” — a specific counter motion of the reflected stripes — reflexes and shadows, resulting from the development of an irregular astigmatism;

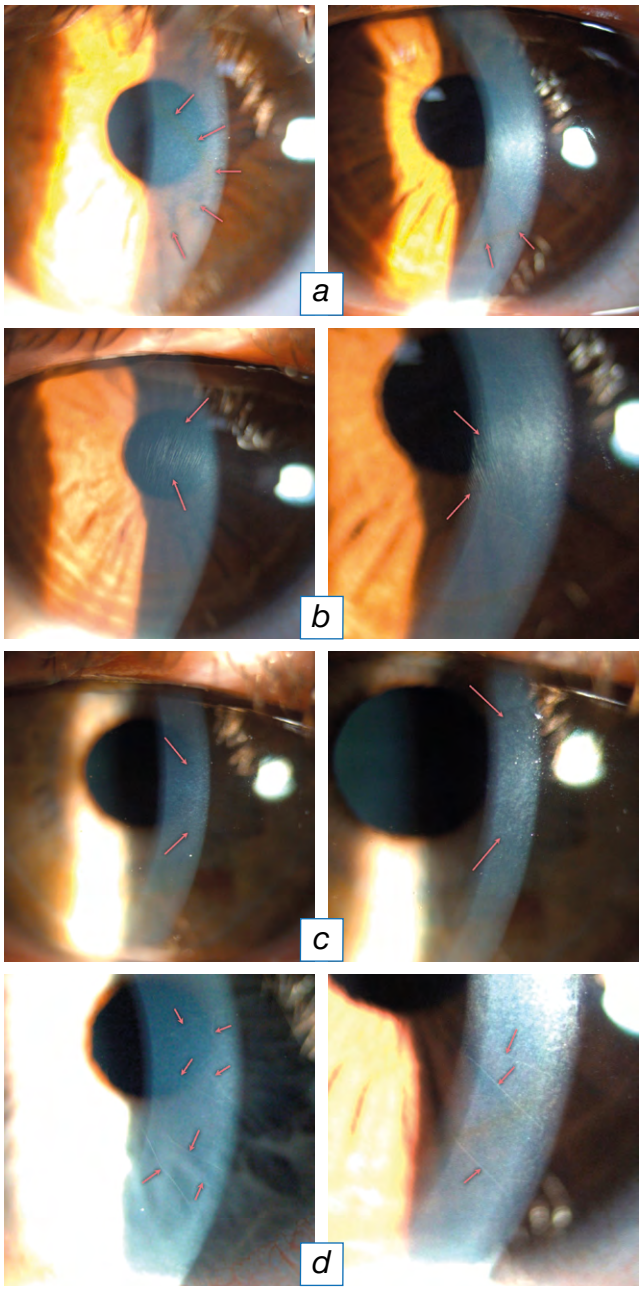

Fig. 2. Slit-lamp imaging of keratoconic cornea (red arrows point keratoconus signs): *a* — Fleischer ring; *b* — Vogt's striae; *c* — fading star or firework symptom; *d* — stromal nerves.

- "oil drop" symptom, or "oil drop/petroleum drop", or Charleaux's symptom, — revealing (upon using direct light) a contour (the base of the cone-shaped deformity — the protrusions) showing a yellowish-orange tint with a background of a red fundal reflex [1, 3–12].

As of today, the gold standard for the diagnostics of keratoconus is the combined examination of the cornea using modern computed keratoanalyzers — diagnostic platforms that allow for visualizing the structure and evaluating the functions of the cornea. The combined computed examination includes keratoscopy and keratotomography with using the original software, which (based on the obtained data) models the shape charts/maps (keratotopography/leveling maps), the refractive power (keratometry maps) and the thickness (keratopachymetry maps) of the cornea, also calculating (in an automatic mode) the shape irregularity indexes, the refractive power (curvature) and the thickness of the cornea along with the probability of keratoectasia presence and the stage of the keratoconus. As a result, a single diagnostic platform (computed optical analyzer of the anterior segment of the eye) allows for performing a complex examination of the cornea, generally, combining such diagnostic methods, as keratoscopy, keratotomography, keratotopography, keratometry and keratopachymetry [1–5, 12–18].

Keratoscopy (videokeratoscopy, photokeratoscopy, keratography) is a method used for examining the anterior surface of the cornea, based on the evaluation and the analysis of corneal ability to reflect (as a reflex) the so-called Placido keratometry disc — a pattern of concentric alternating black and white mire rings of the same width. The basis of the method is the effect of reflecting the rings from the corneal surface: at the high curvature areas (central optical zone), the rings become thinner and closer, while at the area of lesser curvature (periphery of the cornea) the rings expand. In case of keratoconus, the method allows for visualizing the distortion (changes in the shape and width) of the rings — its dislocation, deformation and curving of its contours. In the area of the cornea steeping (the apex of the protrusion), the rings become thinner with their contours converging, the rings group and concentrate downward. At the area of the corneal flattening, the rings expand and rarefy (see Fig. 1, *b*) [1–5, 12–18].

Keratotomography is an optical scanning of the cornea (including the use of the rotational Scheimpflug-camera), based on the results of which, the software built into the computed keratoanalyzer creates a series of optical slices of the cornea. Further digital analysis of the data obtained during keratoscopy and keratotomography is performed by means of analytical software integrated into the equipment for plotting the visualization charts, exercising the following examinations functions:

- keratotopography (elevation/keratotopography maps of the shapes of the anterior and posterior surfaces of the cornea);
- keratometry (curvature /refractive power maps of the anterior and posterior surfaces of the cornea);
- keratopachymetry (corneal thickness maps) [1–5, 12–18].

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In case of keratoconus, the keratotopography (elevation) maps allow for visualizing the forward prominence of the anterior and/or posterior surface of the cornea (protrusion, ectasia) as an area of local elevation (prominence, bulging) of the cornea in relation to the "ideal" sphere (elliptical), directed generally downwards and outwards (temporally) from the optical center (Fig. 3) [1–5, 12–18].

In case of keratoconus, the keratometry maps (corneal refractive power and curvature maps) show typical patterns (Fig. 4) expressed as local steeping area in the cornea (round-shaped pattern, oval-shaped pattern or symmetrical bowtie pattern), directed generally downward and outward (temporally) from the optical center, also expressed as an asymmetrical astigmatism with downward steeping (asymmetrical bowtie or curved bowtie with rounded axes) [1–5, 12–18].

When examining the keratoconus cases using the keratopachymetry maps (corneal thickness maps), the minimum corneal thickness can be defined for keratoconus with the dislocation of the thinnest point of the cornea, generally, downward and outward (temporally) from the optical center (Fig. 5) [1–5, 12–18].

Additionally, the tomography-assisted evaluation of the corneal epithelium allows for visualizing its local thinning at the area of the cone apex and its thickening in the area of the cone base, as a result of which, the corneal epithelium thickness profile gains a ring-shaped (doughnut) pattern. Such an effect in case of keratoectasia develops due to the ability of the corneal epithelium to compensate the irregularity of the anterior corneal surface in cases of its deformation [1–4, 6, 12, 19, 20].

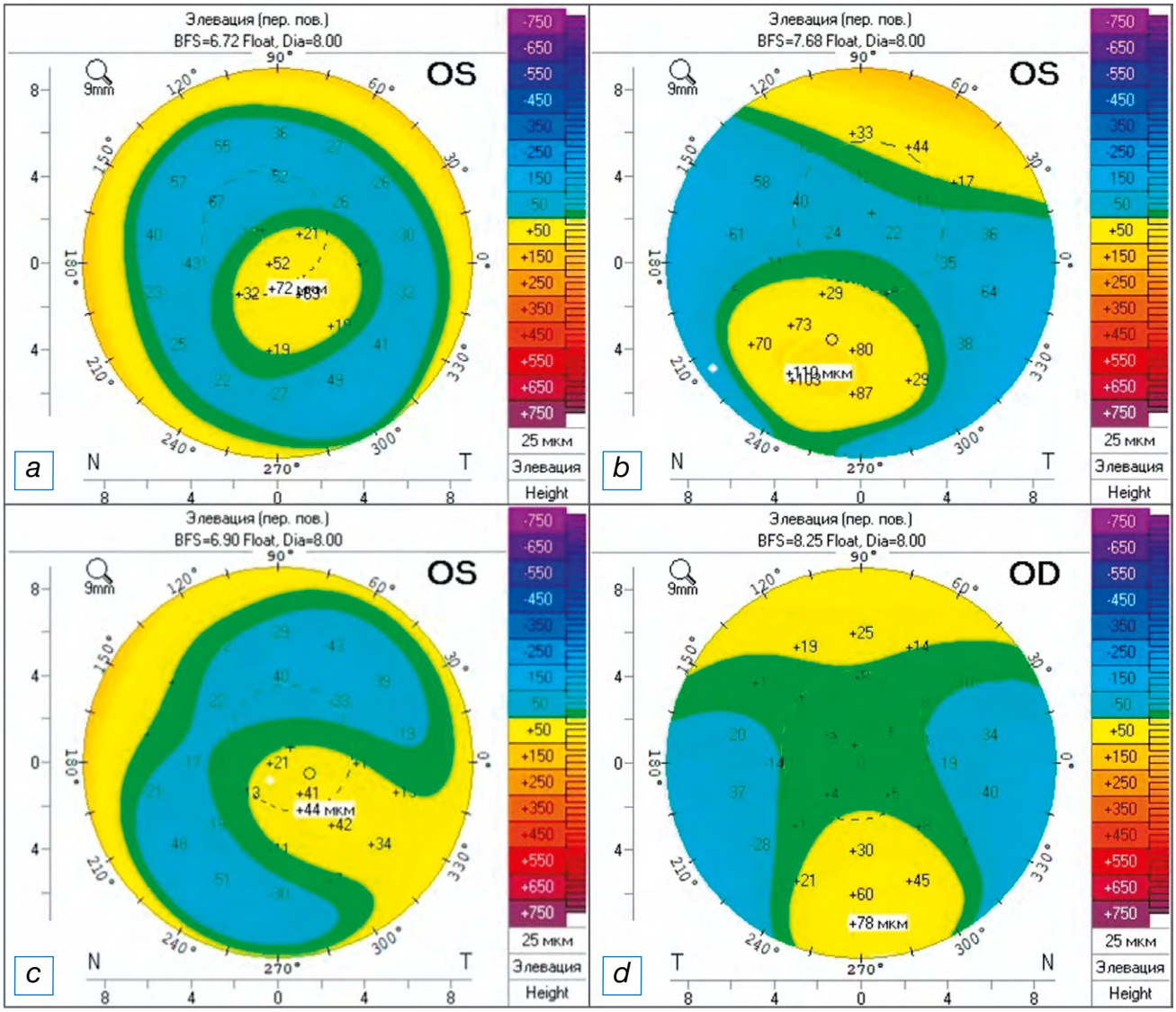

Fig. 3. Cornea anterior surface elevation maps in keratoconus: the local elevation of the cornea anterior surface relatively to the «best-fit sphere» is indicated in yellow with the numerical value (microns) of the protrusion level.

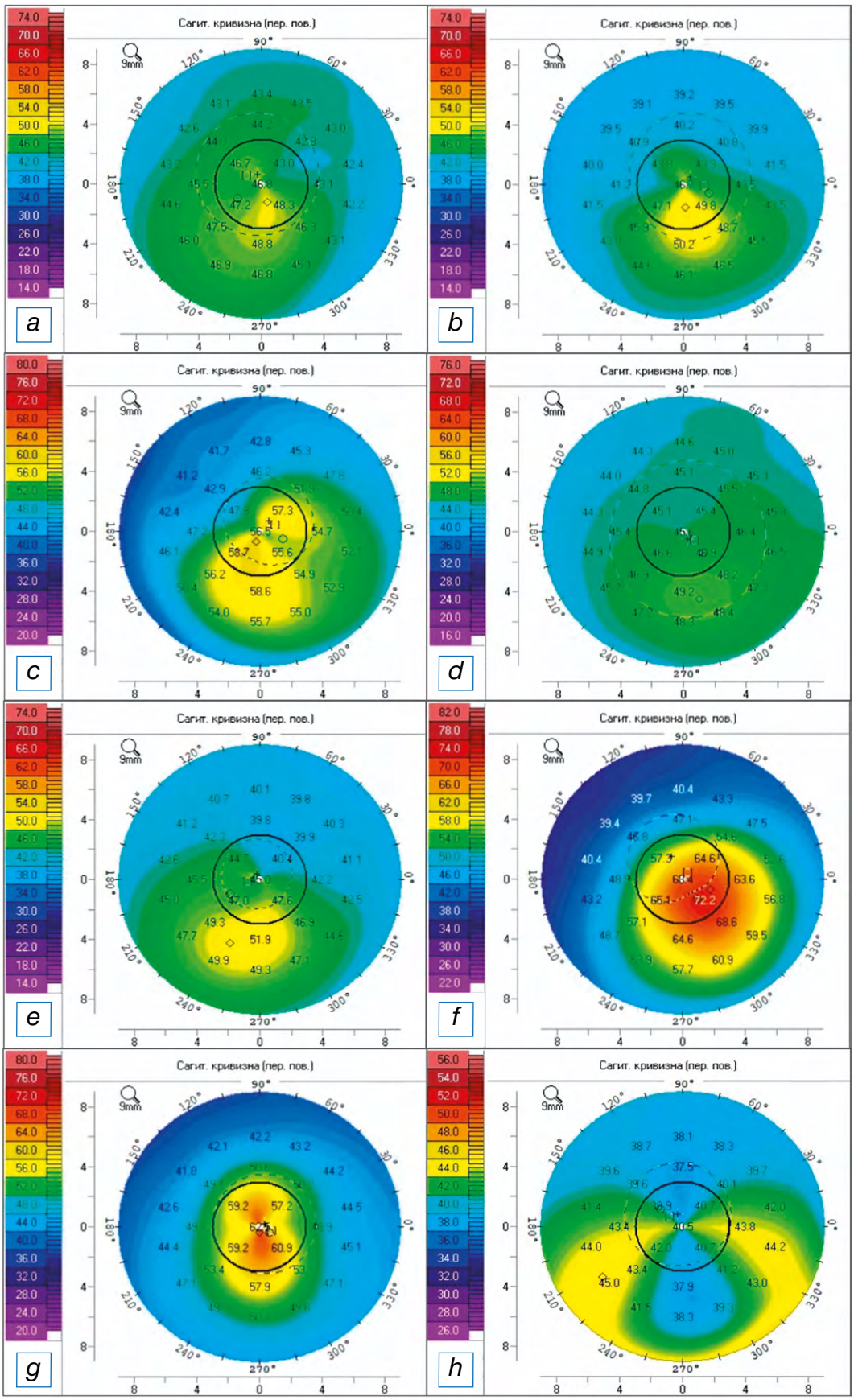

Fig. 4. Cornea anterior surface keratometry maps in keratoconus. The numerical values of the cornea refractive power (diopters) at each point of the map are indicated. Typical keratoconus patterns: *a, b* — asymmetric «bow-tie» with inferior steepening; *c* — «bow-tie» with screwed axes; *d–f* — local inferior steepening; *g* — «baby bow-tie»; *h* — «crab claw», or «kissing birds».

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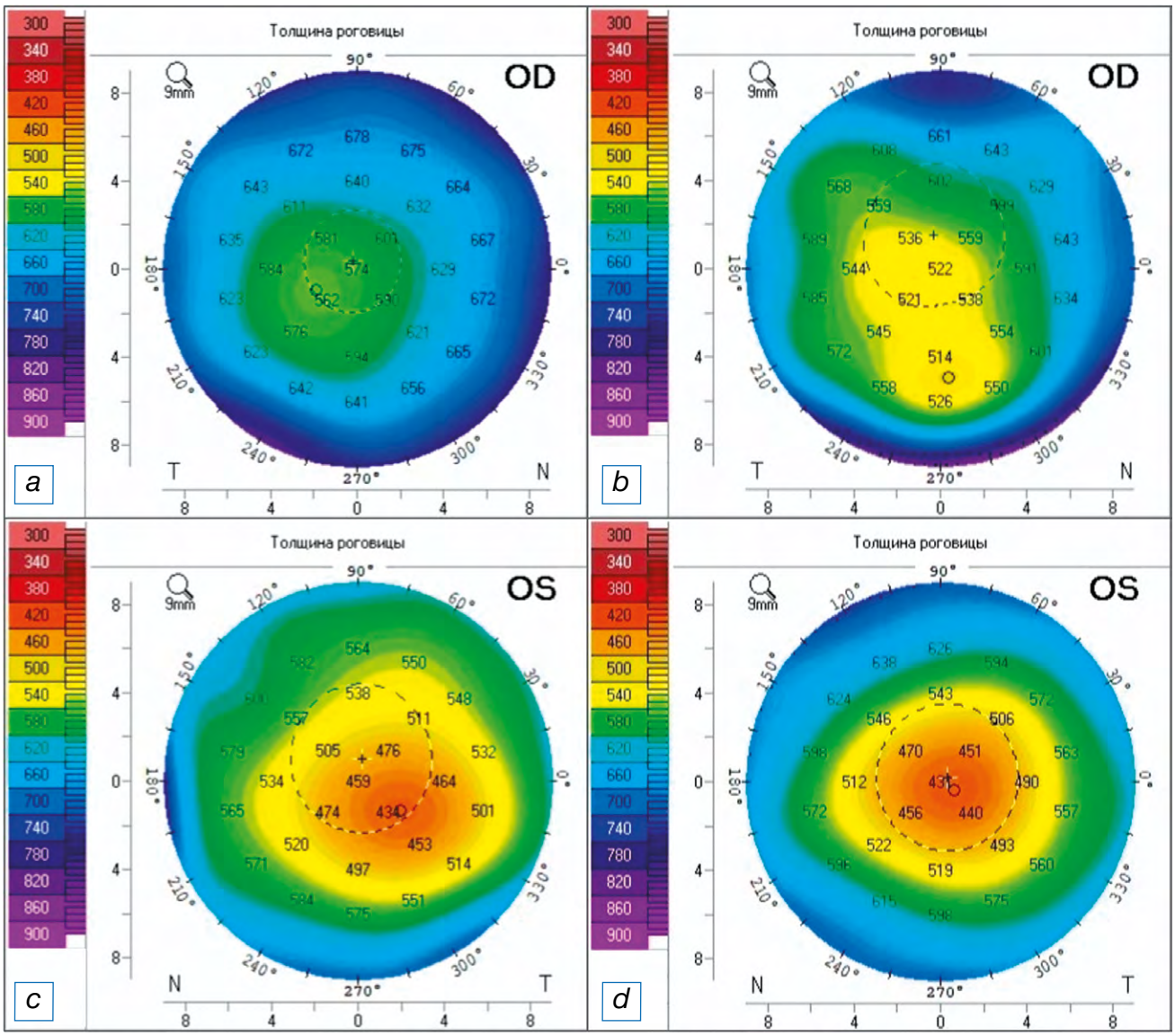

Fig. 5. Cornea pachymetry maps in keratoconus: *a–c* — inferiorly displaced thinnest point; *c, d* — significant decrease in minimal cornea thickness.

Optical coherent tomography of the anterior segment of the eyeball (cornea) allows for evaluating the transparency (absorbance) of the cornea (densitometry), visualizing the corneal layers (keratotomography), measuring the cornea thickness (keratopachymetry) and analyzing the shape of its surface (keratotopography). Optical coherent tomography devices can have the same functions and analytical options as the ones employed in computed optical keratoanalyzers, the fundamental differences include only the technical features of the hardware [1–4, 12, 21].

The necessity for precise verification of keratoconus at the earliest stages of its development is gaining special topicality in ophthalmology practice when drawing up a conclusion on the possibility of performing the surgical (laser) correction of refraction abnormalities. When performing such an examination, special attention should be paid to examining the cornea by using the slit-lamp in order to reveal the specific biomicroscopic signs of keratoconus (for example, Fleischer's ring — even in the absence of keratotopography manifestations). With the aid of modern computed keratoanalyzers, the screening procedures are carried out among the patients that are considered candidates to undergo excimer-laser vision correction, in order to reveal the most initial changes of the shape and the most minimal abnormalities in the curvature of the anterior and posterior surface of the cornea. For the same reason, the research scientists have made attempts to reveal signs of degenerative-dystrophic processes in the corneal tissues at

the stage of keratoconus-related ultrastructural changes (before the development of significant keratotopography signs of keratoectasia) by means of using several additional special diagnostic methods: the analysis of biomechanical properties of the cornea, the corneal confocal microscopy, the corneal specular microscopy of the cornea, the ultrasound examination of corneal epithelium thickness profile, the aberrometry of the eyeball optical system, etc. However, in the absence of keratotopography manifestations of the keratoconus, the abovementioned specific methods used for additional examination have no fundamental independent value in the diagnostics of this disease. They are not sufficiently sensitive and specific, due to which they have not gained any wide spreading in the clinical ophthalmology practice [13, 16–32].

CLASSIFICATION OF KERATOCONUS

The results of conducted diagnostic research allow for not only verifying the diagnosis, but also detailing the type and the stage of the disease. The first classifications of keratoconus in the absence of high-tech methods for evaluating the corneal status were based predominantly on the clinical signs of the disease. The staging of the pathological process was carried out with taking into consideration the vision acuity, the biomicroscopic findings and the refractive power of the cornea according to data from basic keratometry. As of today, a number of authorial clinical classifications for keratoconus have been proposed, allowing for staging the pathological process depending on a number of criteria and application objective: classifications developed by M. Amsler (1951/1961, translated by T.D. Abugova in 1998), by Z.D. Titarenko (1982), by Yu.B. Slonimskiy (1992), by J.H. Krumeich (1998), by M. Amsler and J.H. Krumeich (1998), by M. Hom and A.S. Bruce (2006), by T.D. Abugova (2010), by the Global Keratoconus Foundation (2014), by M.M. Belin “ABCD” (2020) etc. Modern classifications are based predominantly on the results of the computed (keratotopography) keratometry and keratopachymetry with subdividing the keratoconus into four gradual stages in accordance with the severity degree of the pathological process (with some terminological differences): I — initial stage (early, mild); II — progressed (medium, moderate); III — advanced (severe, advanced); IV — terminal (severe) [7, 12, 33–35].

It is worth noting that in practice it is often not possible to determine the keratoconus stage discretely, for even within a single classification, according to the criteria proposed, the clinical signs of the disease math for the adjacent stages (for example, I–II or II–III). Currently, in clinical work, a possibility came up of using the classifications based on the data from computed optical keratoanalyzers: the staging of keratoconus is being performed automatically with using the diagnostic platform software based on the indexes of irregularity in the shape, the curvature and the thickness of the cornea.

Oftentimes, the categorization by the keratoconus stages in the patients is lacking applied significance for the reason of the presence of individual features of the clinical signs in each individual patient and due to subjective manifestations, due to a variety of treatment and correction options in the clinical centers along with the development of personalized approaches in medicine. For the purpose of defining the tactics to be used when managing the patient, the fundamental value belongs to the clinical course of the disease: progressive keratoconus or stable one (non-progressive). The criteria, defining the extent of therapeutic procedures, are the status of the cornea (thickness, curvature and transparency) and the shape of the protrusion. In accordance with shape defined for the keratoconus-related ectasia, it can be classified as nipple-shaped (or local, having a diameter of up to 5 mm), oval-shaped (5–6 mm in diameter) and round-shaped (ball-shaped, having a diameter of more than 6 mm). In terms of the base area (spreading of ectasia), the keratoconus can be classified as dome-shaped (vast, extended, with broad spreading base) or bell-shaped (local, with a localized base). Taking into account the location of the protrusion apex, the keratoconus can be classified into the lower, the upper and the central ones [1–4, 12].

As for the clinical manifestations, the keratoconus can be clinically manifesting, or clinically expressed (manifesting form, manifesting keratoconus) or subclinical [1–4, 12]. Regarding the term “subclinical keratoconus”, the medical community shows some degree of uncertainty. In general, the literature contains a number of terms, semantically proposing the presence of keratoectasia cases with non-typical symptoms or challenging in terms of verifying the diagnosis (the cases of keratoconus, when the disease has no typical clinical manifestations). The first variant is lacking clear manifesting clinical signs of keratoconus: the ametropy does not progress, the visual functions remain stable for many years, while the parameters of the corneal astigmatism, definable upon using the routine methods of standard

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ophthalmology examination (autorefractokeratometry and visometry with maximal spectacle correction), show no clear signs of irregularity. Oftentimes such patients are being specifically managed by ophthalmologists with the diagnosis of "myopic astigmatism"; due to the fact that the suspected keratoconus in such situations does not develop, the keratotopography examinations are not performed in such patients. The second variant includes the keratoconus at the earliest stages of the disease development, when it is difficult to suspect and verify the diagnosis: the specific biomicroscopic signs are not always visualized and not always one can find the characteristic keratotopography signs, while the ultra- and microstructural degenerative-dystrophic changes in the corneal tissues cannot to be found using accessible methods and they are not to be considered as the principal specific and pathognomonic signs of keratoconus. In such cases (most commonly), the patients with no definitive diagnosis or with the diagnosis of "suspected keratoconus" shall be left under follow-up for monitoring purposes and for the evaluation of dynamic changes in the pathological process. For the designation of both variants, the scientific literature and clinical practice employ a number of terms and definitions: "subclinical keratoconus", "pre-clinical", "latent", "delayed", "non-manifesting", "initial", "early", "topographic", "abortive", "hibernating", "subtle", "aborted", "unfulfilled", "uncompleted", "forme fruste", "suspected keratoconus", but in various contexts and with various semantic meanings [14, 31].

Taking into consideration the advances in diagnostic equipment and practically ubiquitous use of computed corneal analyzers, as of today, it is possible to accentuate two keratoconus stages according to keratotopography findings:

- pre-(kerato)topography stage (the stage of ultrastructural changes, while the keratotopography manifestations are still absent);
- keratotopography stage (the stage of ectatic changes, keratotopographically manifesting stage) [31].

DIFFERENTIAL DIAGNOSTICS

Currently, the term "keratoconus" is used to define the initial, or true keratoconus as an independent idiopathic disease of the cornea, as a type of primary keratoectasia. Regarding the secondary corneal protrusion (post-traumatic, post-inflammatory or post-surgical/post-operative or iatrogenic), it is more correct to use the term "secondary keratoectasia" [1–4, 33–39].

Upon examining the keratoconus patients, the differential diagnostic shall be carried out keeping in mind both the primary (idiopathic) and the secondary keratoectasias (developing due to the traumatic lesions in the cornea, due to past episodes of inflammatory diseases, surgical interventions or some independent types of corneal dystrophias). The primary ones include the pellucid marginal degeneration (transparent marginal dystrophy), the keratoglobus and the congenital posterior keratoconus; the secondary ones include the post-surgical (post-keratorefractive, iatrogenic) keratoectasia (secondary keratoconus); the Terrien's marginal degeneration; the Mooren's ulcer and other independent (including the idiopathic, autoimmune, rheumatoid and allergic) marginal impairments of the cornea; the senile furrow degeneration; the deformation of the cornea due to long-term wearing contact lenses [1, 3, 4 12, 40–43]. Besides, the differential diagnostics requires the clarification of such terms as «acute keratoconus» and «posterior keratoconus».

Acute keratoconus, or corneal hydrops (hydropsy) — is a status associated with stromal edema, acutely developing as a result of a rupture in the Descemet's membrane; it can occur both as an emergency acute complication of the keratoconus at its terminal stage or as an independent disease due to other causes [1, 3, 4, 17, 44].

Posterior keratoconus is a term that can be used both in terms of the independent congenital corneal status (with multiple concomitant development abnormalities of the eyeball and of the organism in general) and in terms of the clinical cases, in which signs of keratoectasia are observed only in the posterior surface of the cornea (generally, based on the results of combined examination of the cornea using computed optical keratoanalyzers) [1, 3, 4, 12].

CONCLUSION

Currently, the gold standard in the diagnostics of keratoconus is a combined examination of the cornea using modern computed optical keratoanalyzers, the role of which has significantly increased due to the necessity for timely and maximally early verification of this disease, which is caused by wider spreading of keratorefractive surgeries. Besides, the maximally early diagnostics of keratoconus at the initial stages of its development allows for arranging timely treatment, directed to ceasing the keratoectasia progression, to the stabilization of the pathological process and to preserving the visual functions among young patients of employable age at a sufficiently high level. The wide use of computed optical keratoanalyzers in clinical practice has resulted in a growth in the rates of

detecting the keratoconus at its early stages, as well as the case of keratoconus with no signs of progression — the subclinical forms of keratoectasia. Nevertheless, it should be kept in mind that the routinely employed ophthalmology methods allow for (in a number of cases) clearly verifying the keratoconus, including its earliest stages, preceding the keratotopography manifestations.

ADDITIONAL INFORMATION

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AUTHOR'S INFO

Liudmila S. Pateyuk, MD, PhD;
address: 11A Rossolimo street, 119021 Moscow, Russia;
ORCID: 0000-0002-5757-6719;
eLibrary SPIN: 9389-6307;
e-mail: sweethailtoyou@mail.ru

ОБ АВТОРЕ

Патеюк Людмила Сергеевна, канд. мед. наук;
адрес: Россия, 119021, Москва, ул. Россолимо, д. 11А;
ORCID: 0000-0002-5757-6719;
eLibrary SPIN: 9389-6307;
e-mail: sweethailtoyou@mail.ru

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