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MORPHOFUNCTIONAL CHANGES IN THE CORNEA AFTER LONG-TERM WEARING OF CONTACT LENSES, CONTRIBUTING TO THE DEVELOPMENT OF ARTIFICIAL (SECONDARY) DRY EYE SYNDROME (literature review)

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Abstract: *The last twenty years have been characterized by rapid growth in contact vision correction. If in 1970 there were 1-2 million contact lens users in the world, then in 1986 there were already 25 million. In recent years, the number of such patients has increased to 80 million [9, 13]. However, contact lenses affect the morphology, physiology and immune response of the eye, and therefore require close attention from ophthalmologists [8, 3, 11, 10]. It is known that contact lenses have a mechanical effect on the cornea, and depending on the oxygen permeability of the lenses [Dk/t], the properties of the material, and the wearing regimen, in patients who long-term use of soft contact lenses (SCL), epithelial microcysts, stromal edema, polymegatism and polymorphism of the endothelium [5, 11,14].*

Keywords: *epithelial microcysts, stromal edema, polymegatism.*

The main changes in corneal metabolism in contact lens wearers are the result of impaired oxygen supply to the cornea. When wearing SCL, some flattening of the cornea first occurs, followed by a gradual increase in its curvature [14]. The cause of this disorder is a mechanical change in the shape of the cornea towards the posterior surface and epithelial edema induced by soft contact lenses. This gives us the right to believe that hypoxia plays a major role in any changes in the topography and pachymetry of the cornea caused by wearing contact lenses, and, consequently, in the morphology of the cornea [14, 10, 12]. Changes in the epithelium and proper substance of the eye are possible [12].

Anatomy of the cornea

The cornea is the main refractive lens in the optical system of the eye (about 40 diopters). The diameter of the cornea averages 11.5 mm vertically and up to 12 mm horizontally, its thickness is heterogeneous: in the center it is approximately 500 microns, and at the periphery it can reach 1 mm. The cornea includes 5 layers: the anterior layer of the epithelium, Bowman's membrane, stroma, Descemet's membrane and the layer of internal endothelium.

The anterior epithelial layer is a flat stratified non-keratinizing epithelium endowed with a protective function. It is resistant to mechanical stress and quickly recovers when damaged. Due to the ability of the epithelium to quickly regenerate, scars do not form on it.

Bowman's membrane is an acellular layer of the surface of the stroma. Its damaged surface is subject to scarring.

Stroma is corneal tissue, occupying about 90% of its thickness. It is composed of correctly oriented collagen fibers, in which the intercellular space is filled with keratan sulfate and chondroitin sulfate.

Descemet's membrane is the basal membrane of the corneal endothelium, which is a network of thin collagen fibers. Serves as a reliable barrier to infection.

The corneal endothelium is a monolayer of cells that have a hexagonal shape. It plays one of the main roles in nutrition and maintaining the functions of the cornea, preventing its swelling under the influence of IOP. Does not have the ability to regenerate. With age, the number of its cells gradually decreases.

The endings of the first branch of the trigeminal nerve take part in the innervation of the

cornea. The process of nutrition of the cornea is carried out due to a network of vessels, as well as nerves, tear film and moisture of the anterior chamber.

The properties of the protective function of the cornea are determined by its high sensitivity. The slightest irritation of its surface, for example with a particle of dust, causes an instant unconditioned reflex in a person, expressed in the closure of the eyelids, increased lacrimation and photophobia. Likewise, the cornea protects the eye from possible damage. When closing the eyelids, the eyeballs simultaneously roll up and there is a profuse secretion of tears, which wash away small mechanical particles or chemicals from the surface of the eye.

Diagnosis of corneal pathologies:

Biomicroscopy is an examination of the cornea in the light of a slit lamp, which makes it possible to detect almost the entire spectrum of diseases.

Pachymetry is the measurement of the size of the cornea using an ultrasound device.

Keratometry is the study of the curvature of the anterior corneal surface.

Topography is a computer study concerning the entire corneal surface, with an accurate analysis of its shape and refractive power capabilities.

Microbiological studies - scraping from the surface (under drip anesthesia). If scraping results are inconclusive, a corneal biopsy can be performed.

Impact of contact lenses

When selecting a contact lens, we increase or decrease the refraction of the eye by creating a new cornea-lens optical system. Since soft contact lenses cover the entire surface of the cornea, it is quite obvious that the physiological processes (respiration, metabolism) in it when wearing contact lenses are determined by the characteristics of the lens (material properties, lens design) and wearing mode. In order to understand how contact lenses affect the cornea and what changes they can cause in its structure, it is necessary to have a good understanding of its anatomy and physiology.

The following wearing modes are distinguished:

1. Long-term continuous wearing - continuous wearing of lenses is allowed for up to 30 days. This became possible thanks to the emergence of new materials with Dk/L above 100.

2. Extended wearing - continuous wearing of contact lenses is allowed for up to 7 days (6 nights in a row). It is necessary for the eyes to rest without lenses for 1 night (once a week). Lenses are replaced with new ones weekly.

3. Flexible wearing - occasional night sleep in lenses is allowed (no more than 3 nights in a row).

4. Daytime wear - lenses are removed at night every day. After cleaning, they are placed in a container with a special disinfection solution.

It is possible to classify contact lenses according to the frequency of their replacement.

The following classes of lenses are distinguished: Traditional lenses (available only in bottles) - replacement after 6 months or less.

Scheduled replacement lenses (available in bottles and blister packs) - replacement after 1-3 months.

Frequently scheduled replacement lenses (available only in blister packs) - replacement after 1-2 weeks.

Daily replacement lenses (available only in blister packs) - replacement daily. These lenses require no maintenance at all.

Classification of materials for contact lenses

Materials used for the manufacture of soft contact lenses, at the proposal of the FDA committee, which determines the requirements for the quality of food and drugs in the United States, are divided according to their water content and electrostatic properties (the ability of the surface of the material to carry an electrical charge) into 4 gr. ppy : Group I Nonionic (low electrostatic charge on the surface), low water content (less than 50%); Group II Nonionic, high water content (more than 50%); Group III Ionic, low water content (high electrostatic charge on the

surface); Group IV Ionic, high water content.

Research shows that there is a relationship between the amount of protein deposits on a soft contact lens and the electrostatic charge on its surface. It has been established that when wearing contact lenses made from materials of groups II and III, the amount of lysozyme on the lenses will be almost 3 times greater (37.7 and 33.2, respectively) than from materials of group I for the same period of wear, and for lenses, made from ionic materials with a high water content (group IV), the amount of lysozyme accumulated on the lens increases by more than 60 times (991.2).

Thus, not only moisture content, but also the electrostatic properties of the material affect the ability of the lens to become dirty. All this determines the timing of lens replacement and the care regime for them. Therefore, for group IV lenses, the recommended wearing period, as a rule, does not exceed 2 weeks, and traditional lenses are mainly made from deposit-resistant materials of group I.

Myopia (myopia) is a disease in which a person has difficulty distinguishing objects located at a long distance. With myopia, the image does not fall on a specific area of the retina, but is located in the plane in front of it. Therefore, it is perceived by us as unclear. This happens due to the discrepancy between the strength of the optical system of the eye and its length. Usually, with myopia, the size of the eyeball is increased (axial myopia), although it can also occur as a result of excessive refractive power (refractive myopia). The greater the discrepancy, the greater the myopia.

Violation of one or more of these conditions can change the normal physiology of the eye (structurally and/or functionally), which, together with the presence of clinical symptoms of discomfort when wearing SCL, causes CL intolerance [3].

More than 140 million people worldwide use SCL to correct refractive errors, and this number has remained stable over the last decade, despite the constant development of new technologies to improve the quality of SCL [4]. It is estimated that from 10% to 50% of patients refuse to wear contact lenses within 3 years of starting their use [5]. At the same time, the most common reason is discomfort of wearing SCL; about 70% of patients experience it at the end of the day [6]. Among the noted symptoms, the sensation of dry eyes is the most common [7] - in approximately 40% of cases, while 25% of patients suffer from severe dry eye syndrome (DES) [8], which leads to a decrease in the time of use of SCL, and subsequently and to refuse their use [9].

The presented statistical data indicate that the interaction of SCL with the ocular surface and tear film contributes to the development of artificial (secondary) dry eye syndrome caused by wearing SCL [10].

In this regard, it is extremely important to take into account the physiological factors that lead to the development of intolerance to SSCL, and if they are detected in the early stages, to prevent the process from progressing to the so-called “point of no return”, when patients will have no other alternative but to stop using SCL.

Factors contributing to the development of intolerance to SCL

Corneal epitheliopathy (surface epithelial damage) that occurs while wearing SCL causes a decrease in the barrier function of the epithelium, which increases the risk of infectious diseases. Defects in the epithelial layer can serve as entry points for infectious agents [1].

In addition, with long-term use of SCL, toxic-allergic effects on the cornea, a reaction to the CL material, care products, and deposits on the lenses may occur [11]. In this regard, good CL mobility is extremely important. It ensures sufficient exchange of tears in the sublens space, which allows timely washing of deposits, detritus and breakdown products in order to minimize the risk of an inflammatory reaction [12].

Significant changes in the epithelium and stroma of the cornea can also occur in response to prolonged hypoxic stress that occurs when wearing CL [11]. An in vivo histomorphological study of corneal features in patients using SCL for a long time revealed hypoxic keratopathy, characterized by varying degrees of impairment - from functional to degenerative [1]. Studies have shown that hypoxia leads to the accumulation of lactic acid and carbon dioxide, which stimulate corneal neovascularization and dilatation of limbal vessels. Superficial neovascularization is a relatively common complication that occurs with long-term wearing of CL. As a rule, it is

asymptomatic and disappears when you stop using SCL. However, one should not underestimate the deep neovascularization of the cornea,

While wearing CL, chronic inflammatory diseases of the conjunctiva and blepharoconjunctivitis often occur, which also affects the state of tear production and the function of the meibomian glands [11]. Studies have shown that long-term wearing of SCL leads to dysfunction of the meibomian glands [12]. Due to the contact of the lens edge with the conjunctiva of the eyelids and friction during blinking, partial obliteration of the meibomian gland ducts and a decrease in lipid secretion occur, which leads to thinning of the lipid layer, disruption of its structure and, as a consequence, rapid evaporation of tears. Also, the dysfunction of the meibomian glands is facilitated by the process of chronic inflammation of the ocular surface, which results in keratinization of the meibomian gland ducts [11].

In addition, some researchers separately identify the sliding edge of the eyelid as a portion of the marginal conjunctiva of the upper eyelid, which slides along the ocular surface or the surface of the eyelid when blinking [4]. Epitheliopathy of the sliding edge of the eyelid is visualized when stained with vital dyes and is found in 85% of patients using SCL and complaining of discomfort when wearing SSCL [5, 6]. Although there is currently no clear understanding of the etiology of this condition, there is a hypothesis that epitheliopathy occurs as a result of insufficient hydration, carried out by the tear film and corneal glycocalyx, and ultimately leads to mechanical friction [2].

The role of mechanical friction in the formation of discomfort when wearing SSCL increases when the lens acts on the corneal glycocalyx [12]. It is a hydrophilic barrier formed by the first type of transmembrane mucins associated with the epithelial membrane: MUC1, MUC4, MUC16. Long molecules of soluble mucins MUC5AC, MUC5B, MUC7, etc. are attached to them. (second type), forming a mucin gel on the surface of the epithelium [10]. Research has shown that the corneal glycocalyx plays a key role in reducing friction during blinking and stabilizing the tear film on the ocular surface. Fukui et al. proved that CL disrupts this natural shock absorption mechanism, changing the homeostasis of the mucin layer, which is subsequently one of the factors in the development of intolerance to MCL [7].

In addition, long-term wearing of SSCL leads to a decrease in the stability of the tear film due to disruption of the normal functioning of the lipid layer, which reduces the hydration of both the lens itself and the ocular surface, increases friction and closes the circle of pathological changes.

In addition to changes in the biochemical and biophysical state of tears in patients who wear SCL for long periods of time, the tear film breakup time (TBR) decreases. When comparing VRSP measured both non-invasively and using fluorescein, a statistically significant difference was found in patients who successfully used SCL, in contrast to patients who felt severe discomfort when wearing SCL due to dry eyes [1] . These data are confirmed by studies by Guillon et al., who studied the kinetics of the pre-lens part of the tear film in patients with comfortable and uncomfortable wearing of SCL. In those patients who noted discomfort when wearing contact lenses, VRSP was reduced, less coverage of the lens with tear film in the period between blinks, and a longer time delay between blinks were also detected [2].

Their use is also advisable for prophylactic purposes to reduce the adverse effects of SCL on the structures of the anterior part of the eye. Given the association between discomfort while wearing SSCL and clinical signs such as conjunctival staining, epitheliopathy of the eyelid margin, dysfunction of the meibomian glands and a decrease in VPSP, the negative role of friction of the

However, in a number of cases, the use of tear replacement therapy based on HA is insufficient to completely relieve the manifestations of epitheliopathy. If we are talking about severe stages of dry eye syndrome, then, as a rule, it is recommended to combine low-viscosity drugs with high-viscosity gel-based drugs. However, in patients using SCL, this approach has limitations, since when used, a film is formed on the surface of the CL, which can lead to blurred vision and discomfort. Therefore, during the treatment of severe dry eye syndrome, you should refrain from wearing CL. In such a situation, it is advisable to prescribe a root protector Korneregel (Bausch + Lomb) - 5% dexpanthenol gel. The drug also contains a carbomer, so Korneregel is a combined drug,Dexpanthenol is a precursor of pantothenic acid, which, in turn, is an essential

component of coenzyme A. Pantothenic acid normalizes cellular metabolism, under its influenceexposure causes the formation and regeneration of cellular elements of the skin and mucous membranes, and the strength of collagen fibers increases. When the corneal structure is damaged, dexpanthenol activates mitosis of epithelial cells and accelerates their migration to the wound defect area [9]. Currently, Korneregel, due to its universal nature of therapeutic action, is recommended as a mandatory remedy in the complex treatment of corneal diseases. This applies to the treatment of a burn disease of the eyes, complex therapy of viral cerebral picaches, postponement and reducing the frequency of complications in the form of excessive death of endothelium cells, the adherence of epithelization and restoration of the approval of the percussion epithelium, reducing the frequency of the permits th, ulceration and percoppan of the cape [5]. The mechanical effect of SCL on the ocular surface, even with constant instillation of low-viscosity agents, does not always provide a sufficient degree of moisture to the surface of the lens, which, in turn, can lead to the development of epitheliopathy. In such cases, there is a need to use corneotrophic agents as stimulators of reparative regeneration. Korneregel is prescribed 2 p./day 15 minutes before putting on the contact lens and at night after removing the lens from the eye for 10–15 days, then it is possible to switch to disposable instillations at night. If necessary, it is used for a long time. According to the study, with the use of Korneregel, complete epithelization and restoration of the surface layer of the epithelium were achieved after 7–14 days in patients with severe epitheliopathy and long-term wearing of SCL [5].

Conclusion

Thus, the study of the structure and biomechanical properties of the cornea in soft contact lens users is extremely relevant and requires further study and analysis of this pathology.

When wearing SCL for a long time, it is very important that the patient is under the supervision of an experienced contact specialist. For preventive purposes, to prevent the development of discomfort when wearing contact lenses, it is advisable to use preservative-free low-viscosity tear substitutes based on HA.

If the effect of low-viscosity tear substitutes is insufficient, it is recommended to add a corneoprotector based on 5% dexpanthenol gel - Korneregel to treat superficial defects of the epithelial layer and accelerate epithelization due to its ability to stimulate the process of migration of epithelial cells to the damaged area, as well as stimulation of their proliferation.

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