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MODERN TRENDS IN THE TREATMENT OF KERATOCONUS IN CHILDREN

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ABSTRACT

Keratoconus is a progressive degenerative disease of the cornea that disrupts the structure and organization of the corneal collagen matrix and leads to thinning and protrusion. Keratoconus in children progresses faster and is more severe than in adults, which is due to the age-related structural features of the children's cornea. Until recently, keratoconus treatment included visual rehabilitation in the early stages and surgical treatment in the late stages, while neither treatment method affected the cause of the disease. With the advent of crosslinking as a method of slowing the progression of keratoconus, the approach to treating this disease in adults has changed fundamentally.

Keywords: keratoconus, cornea, crosslinking, children.

INTRODUCTION

Keratoconus is a progressive degenerative disease of the cornea that causes disruption of the structure and organization of the corneal collagen matrix and leads to thinning and protrusion. Distortion of the corneal surface is the cause of myopia and irregular corneal astigmatism, and changes in the histological properties of the cornea can ultimately lead to severe visual impairment, including blindness [1,2]. Due to the introduction of new high-tech diagnostic methods, namely, the advent of keratotopography and corneal tomography, the Sheimpflug camera, the incidence of keratoconus in the population has increased significantly and currently averages 1:2000 people, varying from 50 to 2300 per 100,000 people in different countries [3]. Keratoconus is a polyetiological disease. The role of the genetic factor is undeniable, which has been clearly demonstrated in studies of families with keratoconus: an association of the VSX1, miR-184, DOCK9, SOD1 genes with the risk of developing keratoconus has been proven. However, despite this, the path and mechanism of inheritance have not yet been fully analyzed [4].

MATERIALS AND METHODS

Corneal collagen crosslinking is a technology based on the formation of intermolecular bonds in the polymer structure, which has been used in medicine (in particular, in dentistry) for quite a long time. Corneal crosslinking was first described by Wollensak and a group of doctors from Dresden in 2003 as a promising technology that would slow down or stop the progression of keratoconus [3]. At the time of the first publications, patients with keratoectasias could only count on wearing glasses or contact lenses (CL) and subsequent keratoplasty, which did not always stop the pathological process. The new method turned out to be effective, despite a number of complications, such as corneal syndrome, infections, temporary or permanent corneal opacities and endothelial damage, which is associated with the specifics of the intervention.

RESULTS AND DISCUSSION

Wollensak et al. developed a standard (Dresden) protocol for the cross-linking procedure, which is still the most widely used today. The technique is based on the ability of ultraviolet A in the presence of riboflavin as a photosensitizer to cause the formation of free radicals, which then induce the formation of covalent bonds between collagen strands and stromal proteoglycans (keratocan, lumican, decorin, mimecan) [2], which increases the molecular weight of the polymers and significantly increases the rigidity of the cornea, causing its flattening [4]. However, it is important to know that powerful exposure to ultraviolet radiation together with riboflavin, which is sensitive to radiation with a wavelength of 370 nm, has a moderate cytotoxic effect on keratocytes (causing their depopulation at a depth of up to 300 μm) and endothelial cells [2], which must be taken into account when performing crosslinking in thin corneas [4]. In addition, the positive effect of crosslinking (formation of cross-links) can be enhanced by prolonging the exposure to low-power ultraviolet radiation or by increasing the concentration of oxygen in the air [1]. This stimulates the search for new options for using crosslinking. Gradually, surgeons began to use crosslinking in combination with various interventions on the cornea. For example, laser-induced crosslinking has been used during photorefractive keratectomy, which improves the quality of the ablation surface and forms a membrane-like structure that accelerates epithelialization [2]. Implantation of intrastromal segments in combination with crosslinking provides better results than when these techniques are used separately. Over the past 17 years, crosslinking has firmly established itself as the "gold standard" for the treatment of keratectasia. Its efficacy and safety in adults in the long term have been confirmed by a number of studies. However, the search for ways to improve the routine procedure (transepithelial, accelerated, CL-assisted, local and combined crosslinking, crosslinking with genipin and rose bengal) as well as new areas of application of existing technology, both for the treatment of bacterial keratitis or bullous keratopathy, and as an alternative to scleroplasty (scleral crosslinking) does not cease [3].

Publications describing the standard protocol are the most numerous and are characterized by a larger sample and duration of observation. All articles note the absence of keratoconus progression, the presence of increased visual acuity and improvement in keratometry parameters. However, there are rare complications associated with infection and significant pain syndrome, as well as decreased compliance due to the age of patients. Articles describing the accelerated protocol also note a good result and a comparable number of complications, while using a shorter procedure time, which is really important in children. However, the observation period is a maximum of 2 years, so the long-term results of using high doses of UV radiation in children are not yet known. The articles describing transepithelial crosslinking without iontophoresis contain contradictory information, namely, a number of authors indicate reduced efficiency of the method, while others indicate a moderate positive effect of the procedure. However, a big plus is the painlessness of the procedure and its high safety. All publications concerning crosslinking with iontophoresis indicate results comparable to the standard epi-off protocol, including the depth of the demarcation line, increased visual acuity and improved keratometry data. At the same time, this method is also painless and safe, like conventional transepithelial crosslinking. However, the observation period in the publications is 1.5 years, so an analysis of the long-term results is necessary.

After instillation of local anesthetics, mechanical removal of the epithelium and instillation of normotonic riboflavin 0.1% and/or dextran solution 20% every 2 min. for 30 minutes were performed. Then continuous exposure to ultraviolet A with a wavelength of 364 nm (10 min.) with a power of 9 mW/cm² and instillation of normotonic riboflavin 0.1% and dextran solution 20% were performed. After the procedure, the children were fitted with a therapeutic contact lens and local antibacterial therapy was performed. One child underwent CL-assisted crosslinking; the choice of the protocol was determined by the borderline values of corneal thickness. For the procedure and postoperative use, contact lenses made of Balafilcon A material were selected. Lenses made of this material have previously been used in the management of patients after crosslinking, and they have also proven themselves in situations where it is necessary to use contact lenses (CL) for therapeutic purposes [4]. In this case, CL must meet high requirements, and first of all, have high oxygen permeability [3]. Since prolonged wearing is assumed, Dk/t should not be lower than 125 units [2].

CONCLUSION

Despite the fact that crosslinking has been used in adults worldwide for more than 15 years to treat keratoectasias and reduce the progression of keratoconus, there are insufficient reports of the technique's use in pediatric practice.

This is due to the peculiarities of the pediatric cornea, the difficulties of surgical treatment of children without general anesthesia with gaze fixation, the need to remove the epithelium, which is due to the pain and risk of infectious and other complications, as well as low compliance in children.

Nevertheless, given the more severe course and rapid progression of keratoconus in children, crosslinking seems to be a promising treatment method specifically in the pediatric population. The development of an optimal crosslinking protocol with high efficiency and safety seems to be very important for pediatric ophthalmology; the positive experience of crosslinking in children in the department of microsurgery and functional rehabilitation of the eye in children confirms this.

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