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Exploring Contact Lens Application for Keratoconus: A Comprehensive Review

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Abstract: *Keratoconus is a non-inflammatory corneal ectasia distinguished by apical protrusions and progressive corneal thinning. Optic issues may arise as a consequence of corneal ectasia, and the contact lens assumes a critical function in rectifying such complications. In order to enhance vision in patients with increased irregular astigmatism caused by corneal ectasia, specialised CL designs are necessary.As a result of recent developments in materials and design technology, contact lens treatment for keratoconus has progressed significantly, and an extensive selection of lenses is now available. This review will provide information on a vast selection of contact lenses, including soft and rigid lenses, hybrid lenses, scleral lenses, piggyback contact lenses (PBCL), and softtoric lenses*

Keywords: Management, Treatment

I. INTRODUCTION

Keratoconus is a non-inflammatory, 85% bilateral ectatic condition affecting the axial portion of the cornea. It typically begins during puberty and advances gradually. A bilateral conical protrusion of the central corneal region accompanied by thinning of the inferior and central paracentral regions. Keratoconus patients develop irregular astigmatism as a consequence of corneal thinning, which leads to impaired or defective vision. Spectacles are beneficial during the initial phases of keratoconus when astigmatism is mild. In advanced keratoconus, the functionality of spectacles is considerably restricted, whereas contact lenses are indispensable for the purpose of vision correction and hold considerable importance. As an initial lens, one may select from a variety of contact lens alternatives, each of which varies in severity according to the cone and any concomitant conditions.[1,2,3,4] Placing contact lenses can present a challenge for individuals who have keratoconus. Improving vision while simplifying the process of selecting the ideal contact lens is the objective of this article.

PRE-REQUISITES FOR THE FITTING

For the purpose of determining the initial trial lens index parameter, keratometry and corneal topography are indispensable tools in keratoconus management.[5,6] Patients diagnosed with keratoconus must undergo a trial lens (diagnostic) fitting in order to obtain contact lenses that suit properly.[7] In cases of extensive keratoconus, the corneal apex becomes significantly thicker, thereby increasing the difficulty of fitting the eye. Ultimately, the process of fitting contact lenses for individuals with keratoconus becomes intricate, necessitating additional chair time and numerous diagnostic fitting sessions. When fitting RGP or Rose K lenses for patients with keratoconus, corneal topography characteristics aid in reducing chair time and guaranteeing a proper fit.1 On the basis of the keratometry values at the apex of the cone, Buxton et al. have categorised keratoconus as follows: mild if below 45.00 D, moderate if between 45.00 D and 52.00 D, advanced if between 52.00 D and -62 D, and severe if greater than 62.00 D. These cones may also be categorised as round or oval according to their morphological characteristics.8 The severity of the condition is indicative of the morphology of the cones, including the globus cone, situated in the corneal topography, and the nipple cone, which is small, paracentral, steeper, and located inferiorly or inferonasally; the oval cone, which has an inferiorly or inferotemporally steeper cornea; and the globus cone, which is situated in the corneal topography. Significantly larger is the globus cone, which extends beyond three-quarters of the cornea to the limbus. [9]

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HOW DO WE CHOOSE A LENS?

Improving visual acuity while preserving corneal health and comfort is the fundamental purpose of contact lens installations. Adjusting the alignment of contact lenses has been shown by Barr et al. to reduce corneal scarring. [10]

When feasible, the severity of the keratoconus and the manifest refraction are considered when selecting a lens. For mild keratoconus, a soft or soft toric contact lens may be selected; however, RGP is the lens of choice if the condition worsens. It is common knowledge that soft contact lenses (SCL) provide comfort. [11]. The fitting of any contact lens is contingent upon three critical factors: the diameter, the base curve, and the power. A low minus power lens is recommended for the treatment of mild keratoconus, while a high minus power lens is necessary for the treatment of severe keratoconus, even when refraction is impossible and base curves are steeper.

The diameter is influenced by the position, size, and steepness of the cone. In general, it is prudent to start with a lens that has a relatively tiny diameter, such as 8.7 mm. The fit of nipple cones is simplified due to their diminutive diameter. Fitting patients with an inferotemporal oval or collapsing cone presents a challenge due to the need for lenses with a wider diameter.

SOFTSPHERICAL/ SOFT TORIC LENSES

Soft lenses exhibit their maximum efficacy during the initial phases of keratoconus. Certain individuals diagnosed with keratoconus may experience high myopia; in such cases, flexible contact lenses can be particularly beneficial.

In the process of selecting soft contact lenses, thicker lenses with a low water content should be utilised to counteract irregular astigmatism. Large-diameter lenses are most suitable for situations involving significant apical displacement, globus cones, or large-diameter cones. [12]

Ocu-Flex Toric, HydroKone (Medlens Innovations), Soft K (Advanced Vision Technologies), and Solus Soft K (Strategic Lens Innovations) are among the various soft toric lenses available. Additionally, SpecialEyes 59/54 Toric and Ocu-Flex Toric are also available. It is possible to obtain these lenses with more pronounced base contours. [12,13]

Given their prevalence as the most prevalent form of keratoconus, RGPCLs additionally enhance the prospects of nonsurgical management due to their exceptional optical success rate. [14,15].Bilgin et al. [16] discovered in a study involving 518 Keratoconus patients that RGPCLs averted the need for surgery in 98.9% of the patients.

The primary reason for the optical success of RGPCLs is the formation of a smooth, spherical anterior optical surface, which generates the primary refractive effect. Additionally, the tear layer is shaped into a liquid lens situated between the CL and the cornea, which conceals anterior surface irregularities caused by an ectatic cornea. The elevated higher-order aberrations associated with these irregularities further contribute to the optical success of RGPCLs [17]. Negishi et al. [18] found that despite the enhanced corrected visual acuity of keratoconic eyes with RGPCLs, their visual performance remained inferior to that of normal eyes, both with and without RGPCLs. This conclusion was reached through research into contrast sensitivity.

Due to their practicality, safety, and notable optical success rate in addressing the multifaceted characteristics of Keratoconus, RGPCLs continue to be the treatment of choice for the condition at present.

THE PIGGYBACK CONTACT LENS SYSTEM IN KERATOCONUS

The minimal success of the piggyback CL (PBCL) system, which was initially introduced in 1970 to assist keratoconic patients who were unable to utilise rigid lenses, can be attributed to the low oxygen permeability of the lens materials utilised [19]. The ability of PBCL systems composed of a composite of gas-permeable rigid materials and high-Dk silicone hydrogel to facilitate adequate oxygen delivery to the cornea has been established on account of the high oxygen permeability of both lenses. By utilising the oxygen dissolved in the tears, this technique also allows for its utilisation, as the motion of both lenses promotes the circulation of the tear layer between them [20].

The PBCL system may be more favourable for keratoconic patients who experience irritation and intolerance, inadequate lens stability, or apical epithelial erosion when using RGPCLs [21, 22].

Additionally, there have been accounts of this technology providing optimal CL fitting for patients who have undergone corneal transplantation or intracorneal ring segment implantation but continue to experience progressive or persistent corneal abnormalities [23,24].

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The goal of an optimal PBCL fitting is for the flexible and rigid CLs to move in unison while remaining in separate motion. After inserting the soft lens and observing its motion on the surface of the eye, keratometric measurements are obtained from the front surface of the lens. These values are used to calculate the BC of the rigid lens. Following the insertion of the rigid lens, the compatibility of the lenses with the eye and with each other is evaluated using fluorescein. Numerous studies [21,22,25] recommend positive-powered (+0.50 to +4.0) soft CLs when employing the PBCL system due to their more pronounced front surface curves, which enhance the rigid lens's stability.

However, according to a study by Sengor et al. [21], the majority of patients were able to wear their rigid lenses without a soft lens after an average of six months (range: three to twelve months). This could be attributed to a gradual decrease in sensitivity and habituation.

As a result, the PBCL system is presently a dependable and effective method that can be implemented in patients with KC in order to safeguard the corneal surface against mechanical impacts, enhance the stability of the RGPCL on the irregular cornea, and improve tolerance to CL. This is achieved through the utilisation of the bandage effect facilitated by the flexible lens.

HYBRID CONTACT LENS IN KERATOCONUS

By connecting parts composed of two distinct materials that are rigid at their cores but flexible at their peripheries, hybrid CLs (HCLs) are manufactured using an innovative process. The objective of this type of CL is to integrate the smooth lens comfort of a soft lens with the rigid lens performance [26].

The initial hybrid lenses, namely Saturn II (OPSM, Contact Lenses, USA) and SoftPerm (Sola/Barnes-Hind Incorporated), encountered challenges including corneal hypoxia due to their inadequate oxygen permeability, lens damage caused by structural instability (particularly tears along the fusion line), and subsequent financial setbacks [27].

Despite the paucity of research on hybrid lenses, one study found that 87% of 61 eyes with pellucid marginal degeneration (PMD) and KC (58 individuals) responded positively to SynergEyes KC, a new generation hybrid lens (3 subjects), when it was applied [28].

A separate investigation compared the clinical data and quality of life assessments of keratoconic patients utilising RGPCLs and ClearKone SCLs. The findings revealed that although both lens varieties provided similar visual quality, the ClearKoneSynergEyes SCLs achieved a higher score in relation to quality of life associated with vision [29].

On the contrary, Fernandez-Velazquez [30] drew attention to potential complications that might arise during the use of ClearKone SCLs and emphasised that early circular corneal clouding could indicate a significant issue, in which case SCL use should be discontinued.

Other adverse effects of Synerg Eyes include central corneal clouding and vascularization, both of which are caused by hypoxia. [31] Consequences of ClearKone lens use for five hours should be evaluated for corneal edoema. [31].

Although HCLs are the result of cutting-edge technology that combines the advantageous properties of rigid and flexible materials into a singular lens, additional research is necessary to determine their long-term effects on the cornea and ocular surface.

II. CONCLUSION

Contact lenses can improve the vision of individuals with keratoconus and delay or eliminate the need for keratoplasty.The lens diameter typically chosen for mild to moderate keratoconus is between 7.5 and 8.5 mm. Numerous contact lenses with specialised construction have been created to aid in the fitting of advanced, challenging-to-fit keratoconus cases. Soper lenses are among the most widely recognised lenses. Unusual designs, rigid lenses, flexible lenses, and lenses that combine the benefits of all of these materials are just a few of the numerous varieties of CL that have been created to date. Consequently, the likelihood of resolving the challenges encountered by patients in KC has substantially grown, and it is presently feasible to provide patients with these highly diverse and reversible alternatives to surgical procedures. Although an RGP lens is the preferred option, in the event that the patient encounters distress or intolerance, a transition to a PBCL or a unique soft toric lens may be required in the future. Finally, the use of hybrid lenses is possible.

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