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The unique features and benefits of RGP contact lenses

Summary

Gas permeable contact lenses are also known as rigid gas-permeable (RGP) lenses or oxygen permeable lenses. RGP lenses are rigid, but they shouldn't be confused with old-fashioned hard contact lenses, which were made of a type of plastic called polymethyl methacrylate (PMMA). Despite its excellent optical properties, PMMA material has the significant drawback of limited oxygen passage.The RGP lenses in use today are made almost exclusively of fluoro-silicone/ acrylate materials. Thanks to the improved material composition, it has been possible to produce RGP lenses that not only have higher oxygen permeability, but are also extremely durable and flexible, and have good wettability. This increases comfort, health, and safety during contact lens wear. RGP lenses provide sharper vision and maintain it throughout the day. They are also advantageous in terms of eye health and hygiene benefits. RGP lenses are highly customizable and they correct a variety of refractive errors as well as other vision problems caused by corneal irregularities due to keratoconus, corneal ectasia and other eye diseases. With recent applications, the benefits of RGP lenses for the quality of daily life in keratoconus, which is increasingly diagnosed in the younger population, have increased. The method of controlling myopia by reshaping the cornea using specially designed RGP lenses is called orthokeratology. In this literature review, we particularly would like to highlight the unique features and benefits of RGP lenses and illustrate the reasons why RGP lenses cannot be substituted.

Introduction

RGP contact lenses are a safe and effective tool for visual and refractive correction. They offer numerous advantages for specific ophthalmologic conditions that cannot be effectively treated with glasses or soft contact lenses. By optimizing material properties in RGP lenses, the oxygen permeability and comfort of these lenses have been greatly improved and the occurrence of side effects has been greatly reduced. Because of their unique properties, RGP lenses still play an important role in current eye care applications today will likely continue to do so in the future.

Patients diagnosed with keratoconus represent the group who most benefit from RGP lenses today. In an epidemiological study with a large sample size in the Netherlands, the number of existing cases with keratoconus in the general population was estimated at 1:375 (in other words, an estimated 825 new cases of keratoconus are diagnosed each year in the Netherlands). This proportion in the Netherlands is 5 to 10 times greater than previously reported and can probably be attributed to the increased sensitivity of modern diagnostic equipment. Significantly, it indicates that keratoconus is more common than previously known. In Belgium, around 60% of patients with a recent diagnosis of keratoconus are fitted with one of the special RGP lens types after the initial

evaluation. Considering Belgium's legal population of 11,521,238 in 2021, it can be said that more than 18.000 keratoconus patients in Belgium are in great need of these specialty lenses.

Godefrooij DA, de Wit GA, Uiterwaal CS, Imhof SM, Wisse RP. Age-specific Incidence and Prevalence of Keratoconus: A Nationwide Registration Study. *Am J Ophthalmol.* 2017;175:169-172.

Kreps EO, Claerhout I, Koppen C. Diagnostic patterns in keratoconus. *Cont Lens Anterior Eye.* 2021;44:101333.

RGP lenses are particularly recommended for the following reasons:

RGP lenses are breathable

The fluoro-silicone/acrylate material utilized in RGP lenses allow the eyes to "breathe" by providing a superior oxygen supply. . As a rule, RGP lenses are able to provide more total oxygen to the entire cornea than their silicone hydrogel lens counterparts. The high oxygen transmission ability of RGP lenses reduces contact lens related eye problems.

The high oxygen transmissibility of a RGP lens is a result of both the materials and the ability to exchange up to 20% of the tear volume per blink with these lenses. Silicone and crosslinking agents significantly increase the diffusion of oxygen through the RGP lens. The additional permeability provided by fluorine by dissolving oxygen in fluorinated materials has also reduced the need for using excessive amounts of “silicone”.

Ichijima H, Cavanagh HD. How rigid gas-permeable lenses supply more oxygen to the cornea than silicone hydrogels: a new model. *Eye Contact Lens.* 2007;33:216-223.

Bennett ES: Gas-Permeable Material Selection. In Bennett ES, Henry VA (eds): *Clinical Manual of Contact Lenses (e-book).* Wolters Kluwer, Philadelphia, 2015, Chap 4;96-100.

Better vision quality

When properly fit, the RGP lenses will provide the best vision results of any vision correction option, resulting in close to aberration-free vision. Studies comparing hydrogel soft and RGP lenses have found significantly better visual performance with RGP lenses.

RGP lenses provide better vision correction due to a few different reasons. The rigid material properties and custom-made nature of the RGP lenses provides the superior optical quality derived from a stable and smooth surface. This feature provides wearers with clear and sharper vision all day. RGP lenses do not dehydrate, which is also a cause for reduced vision with other contact lens types. In addition, they do not fluctuate in shape. They also move on the eye with each blink, allowing tears to circulate underneath.

Johnson TJ, Schnider CM. Clinical performance and patient preference for hydrogel versus RGP lense: A crossover study. *Int Cont Lens Clin.* 1991;18:130-135.

Fonn D. Gauthier CA, Pritchard N. Patient preferences and comparative ocular responses to rigid and soft contact lenses. *Optom Vis Sci* .1995;72:857-863.

Timberlake GT, Doane MG, Bertera JH. Short-term low contrast visual acuity reduction associated with in vivo contact lens drying. *Optom Vis Sci.* 1992;69:755.

Ocular health and hygiene benefits

RGP lenses are easy to clean and disinfect. RGPs don't contain water which makes them less likely to attract and proliferate bacteria that can cause eye infections. Also, because RGP lenses have a smooth surface and do not absorb or retain water, protein deposits do not accumulate on the lens, thus maintaining cleaner and healthier lenses and deterring bacterial proliferation. RGP lenses offer the safest form of contact lens vision correction because they provide the lowest risk of developing microbial (infectious) keratitis, which is the most serious contact lens-related eye condition. Compared to daily wear or extended wear hydrogel and silicone hydrogel soft lenses, daily wear of RGP contact lenses has historically resulted in the lowest incidence of corneal inflammatory events and infectious keratitis. There is also less risk of binding from *Pseudomonas aeruginosa* and *Acanthamoeba* for wearers of RGP lenses. In addition, giant papillary conjunctivitis (also known as contact lens conjunctivitis) is less likely to occur with RGP lenses.

Morgan PB, Efron N, Hill EA, et al. Incidence of keratitis of varying severity among contact lens wearers. *Br J Ophthalmol*. 2005;89:430-436.

Stapleton F, Keay L, Edwards K, et al. The incidence of contact lens-related microbial keratitis in Australia. *Ophthalmology*. 2008;115(10):1655-1662.

Schein OD, McNally JJ, Katz J, et al. The incidence of microbial keratitis among wearers of a 30-day silicone hydrogel extended-wear contact lens. *Ophthalmology*. 2005;112:2172-2179.

Ren D, Yamamoto K, Ladage P, et al. Adaptive effects of 30-night wear of hyper-O2 transmissible contact lenses on bacterial binding and corneal epithelium: a 1-year clinical trial. *Ophthalmology*. 2002;109:27-40.

Cavanagh HD. The effects of low- and hyper-Dk contact lenses on corneal epithelial homeostasis. *Ophthalmol Clin North Am*. 2003;16(3):311-325.

Donshik PC. Giant papillary conjunctivitis. *Trans Am Ophthalmol Soc.* 1994;92:687-744.

Suchecki JK, Donshik P, Ehlers WH. Contact lens complications. *Ophthalmol Clin North Am*. 2003;16:471-484.

Ideal for those with astigmatism

Normally, the cornea and lens are smooth and curved equally in all directions. Astigmatism is an imperfection in the curvature of the eye's cornea (the transparent layer forming the front of the eye) or lens (the transparent elastic structure behind the iris by which light is focused on to the retina of the eye). It may be helpful to think of the normal eye as being shaped like a basketball. With astigmatism, the eye is shaped more like an American football or the back of a spoon. When the cornea has a distorted shape, the result is corneal astigmatism. When the shape of the lens is distorted, the result is lenticular astigmatism. In

either case, vision of both near and far objects is blurry or distorted. The effect can be compared to looking into a fun house mirror. When light enters the eye, it is refracted more in one direction than the other, resulting in blurred vision in at least one of the two principal meridians.

Astigmatism is a common type of refractive error which is often present at birth and may occur in combination with other refractive errors such as nearsightedness (myopia) or farsightedness (hyperopia). In Germany, 32.3% of the population between the ages of 35 and 74 years is affected by significant astigmatism greater than 0.5 diopter. Uncorrected refractive error is the most common cause of visual impairment worldwide. The negative functional effect of astigmatism on vision may be greater than that of other refractive errors. If astigmatism is left untreated, it can cause headaches, light sensitivity, fatigue, eyestrain, and blurred vision at all distances.

Wolfram C, Höhn R, Kottler U, et al.: Prevalence of refractive errors in the European adult population: the Gutenberg Health Study (GHS). *Br J Ophthalmol.* 2014;98:857-861.

Pascolini D, Mariotti SP. Global estimates of visual impairment: 2010. *Br J Ophthalmol.* 2012;96:614-618.

Astigmatism can almost always be optimally corrected with properly prescribed eyeglasses or soft toric contact lenses. Another method for correcting astigmatism is by changing the shape of the cornea through refractive or laser eye surgery. According to the literature, RGP lenses are the lenses of choice for the correction of all types of astigmatism. The crucial advantage of RGP lenses is the provision of clear vision and stable correction of astigmatism. Because RGP lenses are hard lenses, they maintain their shape on the eye and do not conform to the unequal contours of an astigmatic eye.

In cases of moderate to severe astigmatism, a standard RGP contact lens may be uncomfortable. In these cases, a toric RGP contact lens may be used. A toric RGP lens has a spoon-shaped back surface that more closely matches the front surface of an astigmatic eye for a more stable and comfortable fit. Bifocal and multifocal RGP lenses are also available.

Kastl PR. Correction of astigmatism with rigid gas permeable lenses. *Ophthalmol Clin North Am.* 2003;16:359-363.

Abou Samra WA, El-Emam DS, Kasem MA. Clinical performance of a spherical hybrid lens design in high regular astigmatism. *Eye Contact Lens.* 2018;44 Suppl 1:S66-S70.

Irregular astigmatism

Considering the center of the pupil as a pole, imaginary lines are drawn around the eyeball that intersect at the poles at both anterior and posterior positions, which are called the meridians of the eye. The flattest and steepest meridians of the eye are termed the principal meridians.

In irregular astigmatisms, the principal meridians are not perpendicular to each other (i.e. separated by angles greater than or lesser than 90) or the curvature varies along different parts of the same meridian. Patients with irregular astigmatism can also be described as having a complex cornea. An eye doctor, however, can diagnose and measure irregular astigmatism using advanced scans of the front of the eye, such as corneal tomography, which provides a 3D map of the shape and curvature of the eye.

The most common primary causes of irregular astigmatism are **keratoconus** and other ectatic corneal diseases. Secondary causes commonly include traumatic corneal scarring, various eye diseases, corneal infections and some forms of prior eye surgery.

Similar to regular astigmatism, irregular astigmatism can cause blurry or distorted vision. It is difficult and often impossible to correct irregular astigmatism with standard spectacles. To improve this condition, the use of contact lenses represents an alternative approach. Contact lenses are considered very effective in irregular corneas and do not represent a risk to patient safety.

As a result of the corneal distortion in keratoconus, glasses and soft contact lenses often do not provide sufficient vision correction. Among the currently available contact lens materials, RGP lenses provide the best visual performance for subjects with keratoconus. Currently, RGP materials produced as corneal, corneo-scleral, scleral or hybrid contact lenses seem to be the ideal solution to improve vision in patients with irregular corneas. The optical quality and rigid nature of these lenses provide a more regular refractive surface by masking underlying corneal distortion and irregularity.

Rathi VM, Mandathara PS, Dumpati S. Contact lens in keratoconus. *Indian J Ophthalmol.* 2013;61:410-415.

Yildiz EH, Erdurmus M, Elibol ES, Acar B, Vural ET. Contact lens impact on quality of life in keratoconus patients: rigid gas permeable versus soft silicone-hydrogel keratoconus lenses. *Int. J. Ophthalmol.* 2015;8:1074-1077.

It is well recognized that RGP lenses improve the quality of life of patients with irregular corneas, principally those suffering from keratoconus. Appropriate correction with newly designed RGP lenses contributes to better vision-related quality of life in keratoconus patients with different grades of severity. Lim and Lim have reviewed a total of 104 selected studies on contact lens wear in keratoconus patients and reported that RGP lens wear provided significantly better vision than glasses and there was no difference in best corrected visual acuity between RGP lenses.

de Jong B, van der Meulen IJE, van Vliet JMJ, Lapid-Gortzak R, Nieuwendaal CP, van den Berg TJTP. Effects of corneal scars and their treatment with rigid contact lenses on quality of vision. *Eye Contact Lens.* 2018;44 Suppl 1:S216-S220.

Jupiter DG, Katz HR. Management of irregular astigmatism with rigid gas permeable contact lenses. *CLAO J.* 2000;26:14-17.

Romero-Jiménez M, Santodomingo-Rubido J, Wolffsohn JS. Keratoconus: a review. *Cont Lens Anterior Eye.* 2010;33:157-166.

Ortiz-Toquero S, Perez S, Rodriguez G, et al. The influence of the refractive correction on the vision-related quality of life in keratoconus patients. *Qual. Life Res.* 2016;25:1043-1051.

Margolis R, Thakrar V, Perez VL. Role of rigid gas-permeable scleral contact lenses in the management of advanced atopic keratoconjunctivitis. *Cornea.* 2007;26:1032-1034.

Lim L, Lim EWL. Current perspectives in the management of keratoconus with contact lenses. *Eye* 2020;34:2175-2196.

Wu Y, Tan Q, Zhang W, et al. Rigid gas-permeable contact lens related life quality in keratoconic patients with different grades of severity. *Clin Exp Optom.* 2015;98:150-154.

Levit A, Benwell M, Evans BJW. Randomised controlled trial of corneal vs. scleral rigid gas permeable contact lenses for keratoconus and other ectatic corneal disorders. *Cont Lens Anterior Eye.* 2020;43:543-552.

Keratoconus is not as rare of a disorder as previously believed. As previously mentioned, according to an epidemiological study, the number of people diagnosed with keratoconus is approximately 46,500 in the Netherlands and 30,500 in Belgium. Thus, over 75,000 people suffer from keratoconus in Belgium and the Netherlands alone and for these patients, while surgery is a viable option, glasses are not.

According to the global consensus report of an international panel of expert ophthalmologists regarding keratoconus, the two most important goals of non-surgical treatment were stopping the disease progression and providing visual rehabilitation. This report argues that different types of RGP lenses are extremely important for visual rehabilitation and best serve this goal, even though they cannot stop the progression of the disease. Keratoconus specialists recommended RGP lenses as the preferred initial therapeutic modality. Keratoconus experts also indicated that surgery should not be recommended for patients should not be directed to surgery if they are satisfied with their vision with these lenses. They also emphasize that there are modified alternative RGP lenses for patients who cannot use traditional small diameter RGP lenses successfully, such as hybrid lenses, scleral lenses, and lenses specially designed for keratoconus.

In light of these facts, it is clear that RGP lenses are critical for young adults with keratoconus, who depend on these lenses for education, work, and daily activities. Without RGP lenses, these patients would have to undergo transplant surgery to achieve the same vision outcome, representing a more invasive procedure for patients and a significant economic burden to society. Preventing surgery by fitting such RGP lenses is better for the patient and more economical for society. Moreover, most post-surgery keratoconus patients still rely on RGP lenses for satisfactory vision because transplanted corneas typically suffer from irregularities in corneal shape. Therefore, different types of RGP lenses continue to be indispensable tools for ophthalmologists and optometrists to help patients with keratoconus lead a normal life.

Gomes JA, Tan D, Rapuano CJ, Belin MW, Ambrósio R Jr, Guell JL, Malecaze F, Nishida K, Sangwan VS; Group of Panelists for the Global Delphi Panel of Keratoconus and Ectatic Diseases. Global consensus on keratoconus and ectatic diseases. Cornea. 2015;34:359-69.

RGP lenses are highly customizable and personalized

RGP contact lenses can be custom made for each patient based on the eye's individual curvature, size, and corneal shape. This type of customized lens provides a wider range of vision correction and a better overall fit and can provide an effective solution to irregularly shaped corneas.

Bennett ES: Gas-Permeable Material Selection. In Bennett ES, Henry VA (eds): *Clinical Manual of Contact Lenses.* Wolters Kluwer, Philadelphia, 2015, Chap 4;89-94.

Suitable for high prescriptions

RGP lenses can correct a wider range of prescriptions than soft lenses. For patients who have been told that they can't wear soft contact lenses because their astigmatism is too high, RGP lenses are a good option. The range of parameters available in RGP lenses is broader than in soft lenses so that RGP lenses are generally preferred by patients with less frequent power prescriptions (eyes with high myopia, hypermetropia) or those with high astigmatism who are not satisfied with their vision in soft contact lenses. RGP contact lenses provide a significant improvement in visual acuity in patients with high regular (corneal) astigmatism compared to the visual acuity achieved with glasses. As the astigmatism increases, the visual benefits of RGP lenses also increase.

Opačić D, Miljak S, Ćuruvija-Opačić K. The level of improvement of visual acuity in high corneal astigmatism with rigid gas permeable contact lenses. *Coll Antropol.* 2015;39:229-232.

Michaud L, Bennett ES, Woo SL, et al. Clinical evaluation of large diameter rigid-gas permeable versus soft toric contact lenses for the correction of refractive astigmatism. A multi-center study. *Eye Contact Lens*. 2018;44:164-169.

Stability, durability, cost-effectiveness and ease of storage

The siliconized and fluorinated acrylate materials in RGP lenses facilitate not only more oxygen permeability, but also more flexibility and durability. Because they are made from a strong material, RGP lenses do not tear and with proper care will outlast other types of contact lenses. RGP lenses do not change shape or color easily; therefore, frequent lens replacement is not necessary. RGPs maintain their firm shape and will not dehydrate. In fact, it has been reported that approximately half of RGP wearers only replace their lenses every 2 to 3 years.

RGP contact lenses prevent discomfort and blurred vision throughout the day because they do not tend to dry out on the eyes.

Storing diagnostic lenses in the hydrated state maintains the lenses in a somewhat sterile state. It is important to note, however, that no contact lens disinfecting solution has been approved for storage for greater than 30 days. In addition,

there are many advantages to keeping the diagnostic lenses in the dry state. It is both efficient and convenient to store the lenses dry because they can be kept in flat-pack cases that occupy very little space. RGP lenses are also easier to keep clean for longer, making RGP lenses cost-effective.

Nichols JJ. Contact lenses 2011. *Contact Lens Spectrum.* 2012;27:20–25.

Ward MA. In-office care and disinfection of diagnostic GP lenses. *Contact Lens Spectrum.* 2011;26:25.

Comfort and security

RGP lenses can be tinted so they are easy to see and handle. They can be made larger as in special scleral and hybrid models, and their edges can be placed closer to the eye surface. These design changes make modern RGP lenses more comfortable and easier to tolerate than old-fashioned hard contact lenses. They also tend to stay more securely on the eye when worn during sports and other activities. A RGP small diameter lens moves more distinctly with each blink. However, vision should not be affected as the RGP lens quickly re-centers.

The addition of fluorine increases the deposit resistance of the lens material promoting a tear film mucin interaction with the lens surface. The primary dryness problem experienced with RGP materials made from silicone/acrylate lens materials is reduced with fluorine. Therefore, the RGP lenses made from fluoro-silicone/acrylate materials are more dimensionally stable, more wettable, and more comfortable.

Bennett ES: Gas-Permeable Material Selection. In Bennett ES, Henry VA (eds): *Clinical Manual of Contact Lenses.* Wolters Kluwer, Philadelphia, 2015, Chap 4;89-99.

Special forms of RGP contact lenses

Those patients with dryness and highly irregularly shaped corneas can experience discomfort with the more common types of RGP lenses. In these situations, RGP lenses with a larger diameter - hybrid lenses or scleral lenses - may be better options.

1. **Scleral RGP lenses**

   Scleral lenses have been one of the most active areas for contact lens innovation in recent years. Scleral lenses are generally manufactured from RGP materials with very high oxygen permeability. They have a much larger diameter than normal RGP lenses and therefore rest on the white part of the eye (sclera).

   The addition of silicon to the RGP lens material has allowed increasingly higher oxygen transmission and the production of larger diameter lenses. The availability of newer RGP materials with high oxygen permeability has addressed concerns about hypoxic damage caused by covering the front surface of the eye with old-fashioned hard contact lenses made of PMMA. Long-term wear of specially designed, large-diameter scleral lenses must

meet the oxygen needs of the cornea; this is only possible with hyper-oxygen permeable RGP lens materials.

Findings from reports on scleral lenses show that they are stable on the eye and well tolerated. A scleral lens provides an opportunity to overcome some of the visual problems associated with an irregular corneal surface and tear film. The most distinguishing feature of scleral lenses is their distinctive large diameter and shape, designed to avoid contact with the cornea, providing better fit and comfort. Three groups of conditions that are otherwise difficult to treat have been reportedly successfully managed with this modality. These include ectatic corneal conditions, ocular surface disease, and irregular or high astigmatism.

These specially designed scleral lenses with a fluid-filled reservoir vaulting over the cornea have proven to be an excellent option for improving irritation symptoms and visual acuity. Scleral lenses provide almost immediate relief in photophobia for severe corneal problem resulting from tear dysfunction.

Scleral contact lenses may be still considered as unique medical devices for patients with complex corneal disease such as keratoconus, and irregular astigmatism rather than lenses for the correction of dry eye and simple refractive errors.

Pullum KW, Whiting MA, Buckley RJ. Scleral contact lens: the expanding role. *Cornea.* 2005;24:269-277.

Harthan JS, Shorter E. Therapeutic uses of scleral contact lenses for ocular surface disease: patient selection and special considerations. *Clin Optom (Auckl).* 2018;10:65-74.

Tan DTH, Pullum KW, Buckley RJ. Medical applications of scleral contact lenses: gas-permeable scleral contact lenses. *Cornea.* 1995;14:130–137.

2. Hybrid lenses

Other additions to the large-diameter class of contact lenses are hybrid lenses, in which the central part of the lens is RGP zone, but the peripheral part is a softer silicone hydrogel. Thus, patients get the superior vision of RGP lenses with the comfort of soft lenses. When evaluated in terms of comfort and visual performance in patients with regular myopic astigmatism and keratoconus, both hybrid material and RGP lenses showed the same performance. They are also beneficial for athletes due to the stability of fit, as well as anyone experiencing difficulty adapting to a standard diameter RGP lenses.

Oxygen is highly transmissible through the RGP materials used in today's large lenses, which alleviates earlier problems of corneal hypoxia. However, that doesn't eliminate all safety concerns. Their soft skirts can make them more vulnerable to damage than fully rigid RGP lenses. Hybrid lens wearers may also have other soft contact lens-related complications.

Leal F, Lipener C, Chalita MR, Uras R, Campos M, Höfling-Lima AL. Lente de contato de material híbrido em pacientes com ceratocone e astigmatismo miópico composto [Hybrid material contact lens in keratoconus and myopic astigmatism patients]. *Arq Bras Oftalmol.* 2007;70:247-254. Portuguese.

Bennett ES: Gas-Permeable Material Selection. In Bennett ES, Henry VA (eds): *Clinical Manual of Contact Lenses.* Wolters Kluwer, Philadelphia, 2015, Chap 4;96-100.

Uçakhan OO, Yeşiltaş YS. Correction of irregular astigmatism with new-generation hybrid contact lenses. *Eye Contact Lens.* 2020;46(2):91-98.

Other special conditions where RGP lenses have been successfully applied in children

Several types of contact lens are available for children. Each has its benefits, and the choice will depend on the individual child's needs. RGP contact lenses are a safe and effective means of treating refractive abnormalities in children. Families can be successfully educated to properly insert and remove RGP lenses on a daily basis.

1. **Aphakia** is the absence of the lens of the eye, which can also affect some infants and children and causes severe visual disturbance. Both soft silicone and RGP contact lenses have been the standard means of optically correcting unilateral aphakia in infancy. Soft silicone lenses are easier to fit but RGP lenses are associated with fewer adverse events. Because RGP lenses have good oxygen transmissibility and offer a wide range of refractive power, some practitioners prefer to use a RGP lens for greater precision and timeliness in correcting the child's refractive error. The "Infant Aphakia Treatment Study Group" investigated visual acuity outcomes in infants who were optically corrected with contact lenses or intraocular lenses (IOLs) after unilateral cataract surgery during infancy. Although both methods of correction resulted in similar grating visual acuity outcomes in the treated eyes at age 1 year, infants treated with IOLs had more surgical complications and required additional surgeries to maintain good vision.

Shaughnessy MP, Ellis FJ, Jeffery AR, Szczotka L. Rigid gas-permeable contact lenses are a safe and effective means of treating refractive abnormalities in the pediatric population. *CLAO J.* 2001;27:195-201.

Lambert SR, Kraker RT, Pineles SL, Hutchinson AK, Wilson LB, Galvin JA, VanderVeen DK. Contact Lens Correction of Aphakia in Children: A Report by the American Academy of Ophthalmology. *Ophthalmology.* 2018;125:1452-1458.

Infant Aphakia Treatment Study Group, Lambert SR, et al.: A randomized clinical trial comparing contact lens with intraocular lens correction of monocular aphakia during infancy: grating acuity and adverse events at age 1 year. *Arch Ophthalmol.* 2010;128:810-818.

2. **Myopia progression:** Several recent studies have found that RGP lenses may slow down the myopia progression and limit axial elongation of the eye over time. One way to temporarily slow the progression of myopia is with an orthokeratology RGP lens which reshapes the cornea via inverted

geometry. A report written in 2018 concluded that orthokeratology is effective for the control of myopia and potentially exhibits superior effects when applied in children aged 6 to 8 years. However, the greatest impact of this technique for this purpose has been achieved in recent years when applied in combination with low-dose atropine.

Orthokeratology is a treatment in which the patient wears RGP lenses overnight to flatten the cornea (overnight orthokeratology). They are worn while sleeping and temporarily to provide some vision correction during the day. Currently, overnight orthokeratology is approved by the FDA for the treatment of myopia up to 6 diopters. More recently, one lens design has received regulatory approval for myopia control in Europe. This is very important for children who rely entirely on close work for learning and whose myopia is still progressing but may be slowed or halted.

3. **Traumatic corneal scarring in children:** The optical performance of RGP lenses has proven effective in the visual rehabilitation of young children in with traumatic corneal damage. RGP lenses prevent amblyopia (lazy eye) in these patients by creating a new optical surface for the damaged or scarred cornea and optically eliminating surface irregularities.
4. Innovative scleral or hybrid RGP contact lenses are considered most effective for children with a broad range of refractive and ocular disorders.

Bullimore MA, Johnson LA. Overnight orthokeratology. *Cont Lens Anterior Eye.* 2020;43:322-332.

Walline JJ, Jones LA, Sinnott LT. Corneal reshaping and myopia progression. *Br J Ophthalmol.* 2009;93:1181-1185.

VanderVeen DK, Kraker RT, Pineles SL, Hutchinson AK, Wilson LB, Galvin JA, Lambert SR. Use of orthokeratology for the prevention of myopic progression in children: A report by the American Academy of Ophthalmology. *Ophthalmology.* 2019;126:623-636.

Swarbrick HA, Alharbi A, Watt K, Lum E, Kang P. Myopia control during orthokeratology lens wear in children using a novel study design. *Ophthalmology.* 2015;122:620-630.

Katz J, Schein OD, Levy B, Cruiscullo T, Saw SM, Rajan U, Chan TK, Yew Khoo C, Chew SJ. A randomized trial of rigid gas permeable contact lenses to reduce progression of children's myopia. *Am J Ophthalmol.* 2003;136:82-90.

Liu YM, Xie P. The safety of orthokeratology. A systematic review. *Eye Contact Lens.* 2016;42:35-42.

Chen Z, Huang S, Zhou J, Xiaomei Q, Zhou X, Xue F. Adjunctive effect of orthokeratology and low dose atropine on axial elongation in fast-progressing myopic children: A preliminary retrospective study. *Cont Lens Anterior Eye.* 2019;42:439-442.

Cho P, Cheung SW. Retardation of myopia in orthokeratology (ROMIO) study: a 2-year randomized clinical trial. *Invest Ophthalmol Vis Sci.* 2012;53:7077-7085.

Hiraoka T, Kakita T, Okamoto F, Takahashi H, Oshika T. Long-term effect of overnight orthokeratology on axial length elongation in childhood myopia: a 5-year follow-up study. *Invest Ophthalmol Vis Sci.* 2012;53:3913-3919.

Elseht RM, Nagy KA. Rigid gas permeable contact lens as a vision-sparing tool in children after traumatic corneal laceration. J Pediatr Ophthalmol Strabismus. 2018;55:178-181.

Conclusion

Thanks to their fluorosilicone/acrylate content, modern RGP lenses allow more oxygen to enter the eyes, provide sharper vision and more accurate correction of astigmatism, and last longer than other soft contact lenses. Moreover, the risk of allergic, inflammatory and infectious events with RGP lenses is much lower. In addition to these advantages, specialty RGP lenses provide a more comfortable experience for patients with irregular astigmatism and keratoconus, a corneal disease which is increasingly being diagnosed in the younger population. Currently, there is no cure for keratoconus; improving visual acuity and delaying the progression of the disease are the main clinical intervention goals. RGP contact lens are the most suitable non-operative management option for patients with keratoconus, which can provide satisfactory visual quality and improve the regularity of corneal surface. The positive effects of RGP lenses on the quality of daily life in keratoconus patients have increased with recent applications. Not only due to their unique properties, but also due to the emergence of new fields of application with the production of specialty models, RGP lenses cannot be substituted.

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