Overview of the Main Types of Contact Lenses for Aphakic Children Under 5

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Abstract

Contact lenses are often the first choice for visual correction of aphakic children. There are several types of lens that can successfully be fitted to correct ametropia, stimulate visual selecting, and maintain ocular health. Several factors are important for choosing the type of lens. Usually, the first lens fitted is made of silicone (Elasofilcon A, Bausch & Lomb, Rochester, NY) with an evolution to a custom silicone hydrogel lens over time. Although fitting in young aphakic children presents many challenges, contact lenses often remain the best option for the correction of refractive errors after congenital cataract surgery. An overview of the main types of contact lens available for aphakic children and their characteristics are presented.

Résumé

L'ajustement en lentille cornéenne est souvent le premier choix pour la correction visuelle des enfants aphaques. Il existe plusieurs types de lentilles qui peuvent être ajustées avec succès pour corriger l'amétropie, stimuler adéquatement le développement visuel, mais également préserver la santé oculaire. Plusieurs facteurs sont déterminants pour le choix du type de lentille. Habituellement, la lentille initialement ajustée est en silicone (Élastofilcon A, Bausch & Lomb, Rochester, NY) avec une évolution vers une lentille silicone hydrogel sur mesure avec le temps. Bien que l'ajustement chez les jeunes enfants aphaques présente de nombreux défis, les lentilles cornéennes demeurent souvent l'option de choix de la correction des amétropies après une chirurgie de cataracte congénitale. Un survol des principaux types de lentilles cornéennes disponibles pour les enfants aphaques ainsi que leurs caractéristiques sera présenté.

The terms "congenital cataract" or "infantile cataract" are used to describe significant opacification of the crystalline lens in the first year of life.[1] Cataract is considered as the most important avoidable cause of visual impairment in children.[2,3] The prevalence of congenital cataract is estimated at 1 to 15/10,000, depending on the criteria used in diagnosing cataract, and the population studied. If a cataract is dense, central and over 3 mm in diameter, if a back of the eye examination is not possible, or if the cataract is associated with strabismus, surgery is required.[4] This should be carried out as early as possible, and certainly within the critical period for vision development, that is before 17 weeks.[5]

Between 2 days and 2 weeks after the surgery, refractive error secondary to aphakia must be corrected to prevent amblyopia, which can develop quickly in the very young.[6] The two most common methods now used to correct vision are eyeglasses and contact lenses.[3,7] Insertion of an intraocular lens (IOL) is less common in children under 1 year, because of the wide variations in refractive power that develop during the early years of a child's life as a result of axial elongation of the eye.[3,8,9]

The fitting of contact lenses is often the first choice in correcting the vision of aphakic children.[7,10] Apart from the aesthetic improvement, image size perceived, aniseikonia, peripheral distortions, ring scotoma (known as the "Jack in the box effect") with limited visual field, and of a pair of glasses equipped with thick lenses are all reduced.[10,11] These aspects are all more important in unilateral aphakia. Moreover, changes in refractive error as a child grows can be addressed easily by changing the lens parameters as required. There are several types of lens that can be fitted successfully to young children. Whether the lens is soft, rigid gas-permeable (RGP) or scleral, the goal is to compensate for the subject's ametropia, in order to stimulate proper vision development, and to preserve eye health by selecting a material and a design that will enable satisfactory oxygenation of the cornea. This article presents an overview of the main types of contact lens fitted to aphakic children, and their characteristics.

FITTING OF CONTACT LENSES

During the first 18 months of life, the eye grows rapidly. Growth generally leads to a reduction in hypermetropia, an increase in the diameter of the cornea, and a reduction in corneal curvature. Frequent changes in the diameter, curvature and power of the lens should adjust to these developments, particularly during the first two years of life.[10]

Keratometer measurements of corneal power are sometimes impossible to obtain, particularly in children under 2, which means that the basic assessment may have to be done under a general anaesthetic.[5,10,12] Average values from previous studies are often used as a starting point.[10,12,13] Russell et al. have reported corneal power at birth between 47.00 D. and 48.50 D., as measured with the keratometer, and quicker flattening in aphakic patients. A baby has an average corneal power at initial fitting of 46.3 D. ± 2.8 D., and at 1 year of 44.6 D. ± 2.3, with an average reduction of 0.2 D. ± 0.2 D./month.[12]

Dioptric power also varies during the early years.[5,10] The average power needed in the very young is higher (+25.5 D. ± 4 D. at 3 months) and becomes less convex over time (+17.94 ± 3.8 D. at age 3) as the eye grows. This represents a variation of 0.23 D. per month.[5] Corneal diameter measures an average of 10 mm at birth, and reaches adult size with a diameter of 11.7 mm at about age 2.[10]

The very young lives in a near-sighted world.[10] Since children who have undergone extraction of the crystalline lens lose the ability to accommodate, compensation for near vision is required. Correction of +2.50 to +3.00 D. is generally added to the distance visual correction prescription to provide appropriate near vision.[8,13] The correction should be reduced to +1.00 or +1.50 at 18 to 24 months, as the child becomes more interested in distant objects. At age 3 or 4, the contact lens should be modified to correct distance vision, and eyeglasses should be provided for near vision.[10]

Ultraviolet (UV) light is associated with a variety of eye diseases.[14,15] An aphakic eye can be more vulnerable to UV light because of the absence of the crystalline lens, which provides partial filtration. Some types of lens offer the possibility of adding UV filtration, but there are no clinical studies confirming the necessity for it.[12]

There are other factors leading to a succesful contact lens fitting.[11] First, parents are responsible for insertion and removal. Their dexterity and motivation are therefore key factors. Numerous visits are also required, in addition to the many pre- and post-operative appointments following cataract surgery. Lenses can also be misplaced or even lost, since children tend to rub their eyes frequently. Children under 8 reportedly lose an average of one lens every 9.2 months.[3] This leads to additional expense, on top of what is often a high initial cost for such lenses.[12] As soon as the child is old enough to understand, it has to be explained that the contact lens is a benefit for him or her, and not a punishment.[3,11] When correction is unilateral, the benefit of the lens is not always obvious to the child, accustomed as they are to using only their good eye.

FITTING OF SOFT LENSES

Soft lenses are most often prescribed for children, because they are the easiest to handle and to fit.[10] Corneal curvature in a newborn is between 48.50 D. (6.96 mm) and 47.00 D. (7.18 mm), and comes close to the adult value – 43.25 D. (7.8 mm) – at about age 3.[10,12] The initial fitting is generally 0.5 mm flatter than average corneal curvature.[10] For a newborn, therefore, the ideal initial curvature would be 7.4 mm. Regular changes in lens curvature is necessary, given the rapid flattening of the cornea that occurs during the first 18 months of life.[10] The diameter of a soft lens is usually 2.5 to 3.0 mm larger than the horizontal diameter of the iris. Since the corneal diameter in a newborn averages 10 mm, the initial diameter selected in most cases is 12.5 to 13.0 mm, and will evolve as the child grows.[10] A lens that allows too much movement will be considered too flat, and will have to be steepened. A lens fitted with too much movement, on the other hand, will have to be flattened in order to promote adequate tear flow beneath its surface. Lastly, the curvature/diameter ratio can be affected by the specific design of the lens, and its power. A larger diameter allows better centration and stability of the lens. However, it sometimes becomes difficult for parents to handle a lens if the diameter is too large.[10]

SILICONE POLYMER SOFT LENSES

Aphakic children should use extended-wear lenses in order to reduce handling concerns and provide constant stimulation of eyesight. Only one type of lens is currently approved for 30-day extended wear in treating paediatric aphakia: the Elastofilcon A silicone lens (Silsoft; Bausch&Lomb, Rochester, NY).[16] This represents the lens of choice, since oxygen permeability (Dk) is 340 X10^{-11} cm^2 mL O_2/sec mL mm Hg with oxygen transmission (DK/t) of 58 at 0.61 mm.[12] A paediatric version is available with power ranging from +23.00 D. to +32.00 D. with increments of 3 D. Diameter is 11.3 mm, and 3 base curves are available: 7.5 mm (45.00 D.), 7.7 mm. (43.75 D.) and 7.9 mm (42.75 D.).[16] The 7.5 mm-base curve lens is usually fitted first, since it comes closest to the theoretical values obtained up to age 18 months.[5,10] Flatter curvature is needed as the child grows: the 7.7 mm and 7.9 mm curvatures are generally used after age 2. By age 4, almost all patients require the 7.9 mm curvature.[5,10,12] The Elastofilcon A has drawbacks, as well as advantages: high cost for acquisition and replacement costs can limit its use. Furthermore, lens diameter quickly becomes too small as the eye grows. It does not incorporate a UV filter. Lastly, silicone is a compound that strongly attracts tear lipids, making frequent replacement necessary: 2 to 4 times a year, depending on the patient's tear profile.[10]

CONVENTIONAL HYDROGEL SOFT LENSES

Conventional hydrogel soft lenses for daily wear are available with a range of parameters, which makes fitting easier. The material is much more resistant to lipid deposits, although it has a strong affinity for proteins. These lenses can be replaced annually, and a UV filter can be added. The initial and replacement costs of hydrogel lenses offer substantial savings for parents. On the other hand, oxygen transmission is not adequate at high convex power, to maintain ocular health, and this very much limits their appeal.[10,17,18] They can in fact cause neovascularization, stromal edema and even chronic endothelial dysfunction.[19]

DISPOSABLE HYDROGEL SOFT LENSES

Few disposable hydrogel soft lenses are available in high convex powers corrections. The Benz-G lens offers custom specifications for this category of patient.[20] The omafilcon A lens offers up to +20 D, with a curvature of 8.6 mm and a diameter of 14.2 mm, and requires monthly replacement.[21] Regular lens replacement minimizes deposit adsorption and the risk of infection. The oxygen permeability problem remains, but the ease of movement optimizes circulation tear flow under the lens surface. Movement partially offsets the inherent risk of infection from debris accumulated under the surface of the lens.[22] In many cases, the flatter base curvature and greater diameter limit use of such lenses to older patients: from age 3 and over.

HYDROGEL SILICONE SOFT LENSES

Disposable lenses are also available in silicone hydrogel. Basically, this is a hydrophilic material offering greater permeability through the addition of silicone to the matrix. The modulus – or relative rigidity – of the lens is increased, as is its wetting angle, which can cause discomfort. These lenses sometimes lead to irritation and the development of giant papillary conjunctivitis resulting from mechanical stress on the ocular surface. They are available in various parameters, and can even compensate for refractive astigmatism. However, because of the thickness of the lens associated with a high refractive power, correction remains easier and more accurate with the use of a spherical lens combined with eyeglasses to correct residual astigmatism.[10] This type of lens is not available with a UV filter.[20]

GAS-PERMEABLE LENSES

Gas-permeable lenses can also be prescribed for children of any age, provided parents are careful about insertion, removal and care. They offer many advantages. They have far superior oxygen permeability and can be manufactured to almost any specification. A UV filter can be added. Even irregular corneal astigmatism can be corrected, which is most helpful in the case of traumatic cataract involving the cornea.[10] Infections and corneal neovascularization are much less frequent compared with soft lenses.[5,6,10,19] On the other hand, a comfortable initial fit can be harder to achieve, and if a child rubs his or her eyes frequently, this can cause irritation, corneal abrasion, and even ejection of the lens.[10]

SCLERAL LENSES

Mini-scleral and scleral lenses can now be considered at any age. They are more complicated to fit, but this is largely offset by the superior quality of vision obtained, particularly in the presence of corneal astigmatism or irregular cornea. They do not touch the cornea, but they are supported partly by the tear fluid under its surface and the conjunctiva, where they land. They offer comfort comparable to that provided by soft lenses, with all of the benefits of semi-gas permeable lenses. They have higher oxygen permeability than hydrogels, and are comparable to silicone hydrogels if fluid clearance is optimal. The material offers a full UV protection. Deposits rarely form in sufficient quantity to impair vision or patient comfort. Scleral lenses offer an excellent alternative.[23] Paediatric use is not common at the present time, however, because of the initial cost – about 10 times that of smaller gas-permeable lenses – and their larger diameter, which can make them more difficult for parents to handle initially.[10]

FOLLOW-UP

Regular changes in the type of contact lens are required as a child grows. The Elastofilcon A lens generally used in an initial trial will be replaced in time by a custom silicone hydrogel. The transition is usually prompted by the limitations associated with the diameter of the silicone lens and the presence of deposits that make very frequent replacement necessary; both can cause patient discomfort. Product replacement cost is also a factor in lens selection.[5,10,12]

Young patients wearing contact lenses must be monitored regularly in order to avoid secondary effects. Studies have shown that in school-age children, contact lenses can be used with a safety factor comparable to that for older patients.[11] The psychological impact of wearing contact lenses is not insignificant: better social acceptance, improved self-esteem, more involvement in sports and physical activity, better overall vision and an improved quality of life.[9,24,25] Even children who love their eyeglasses see benefits in wearing contacts, particularly when refraction issues are of the kind seen in aphakic children.

CONCLUSION

While the fitting of contact lenses in young aphakic children presents numerous challenges, they remain in many cases the option of choice for the correction of refractive error after congenital cataract surgery. The choice of soft contact lenses for aphakic children is limited by the availability of some parameters, and by the question of oxygen permeability. Developments in the availability of materials are making it easier to select a lens that meets patient needs. It is now possible to provide appropriate stimulation of vision development, while preserving ocular health.

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