The goal of any contact lens is to provide adequate vision with maximum comfort over a prolonged period of time. With rare exception, a rigid gas permeable material is the lens material of choice. Currently, there is some balance needed in choosing a material with high oxygen flux versus a material with greater durability and deposit resistance. A number of contact lens designs for fitting keratoconus have been suggested. The advantages and disadvantages of the major lens designs are discussed in the succeeding sections.

**Rigid Gas Permeable Lenses**

Rigid gas permeable corneal lenses are the lenses of first choice for correcting the irregular astigmatism which occurs as the cornea changes shape. The aim is to provide the best vision possible with the maximum comfort so that the lenses can be worn for a long period of time. A mild to high Dk/t material is preferred as it provides the stability required for these high powered lenses.

**Fitting Methods**

1. **Three-point touch design**

   The three-point-touch design is the most popular and the most widely fitted design for keratoconic patients. The aim is to distribute the weight of the contact lens as evenly as possible between the cone and the peripheral cornea. Three-point-touch refers to minimal apical clearance in the center, minimal area of touch /bearing in the mid periphery with adequate edge
clearance. This type of fitting works well for small central cones.

2. Apical clearance fit
(Steep fitting)

In this type of fitting technique, the lens vaults the cone and clears the apex, resting on the para central cornea. This type of lens was suggested as it was argued that apical clearance would minimize trauma to the central cornea. Apical clearance lenses are small in diameter (8.0 mm) and have small optic zones (5.8 mm). The apical clearance method works well on cones which have central apexes or on displaced apexes which are only slightly inferior to the visual axis.

This method, best for smaller cones, is impractical for large cones, such as a sagging oval cone or globus cone. The potential advantages of reducing central corneal scarring are outweighed by the disadvantages of poor tear film, corneal oedema and poor visual acuity as a result of air bubbles becoming trapped under the lens.

3. Apical bearing fit
(Flat fitting)

This apical bearing fitting philosophy is useful for displaced apexes.

As keratoconus develops, the apex of the cornea is generally displaced inferiorly. If a small lens is placed on an inferiorly displaced apex, the lens is generally positioned low, and the lid often dislocates the lens with each blink. In such cases, a lens of larger diameter (9.0 to 9.8 mm) is preferable. The fitting method positions the upper edge of the lens under the upper lid to prevent lens dislocation. Good visual acuity is obtained as a result of apical touch. It has been reported that flat fitting contact lenses can lead to progression or acceleration of apical scarring.
Different types of RGP lens designs

Mild Keratoconus (<45D)
Aspherics or multicurve lenses
Kera 1 and II (No.7)
Acuity K
Rose K (David Thomas)

Moderate Keratoconus (45-52D)
Kera II
Quasar KNO7
Rose K (David Thomas)
Woodward KC3

Advanced Keratoconus (53-62D)
Kera II/III
Rose K (David Thomas)
Profile K (J Allen)

Severe Keratoconus (>62D)
Boston Scleral Lenses
Large diameter lenses
S-Limm (J Allen)
Dyna-intra limbal (No.7)
Rose K Lens (David Thomas)

The Rose K is a unique keratoconus lens design with complex computer generated peripheral curves based on data collected by Mr. Paul Rose, an optometrist, from New Zealand. It is the worlds most frequently prescribed gas permeable lenses for keratoconus which is FDA approved. The system (26 lens set) incorporates a triple peripheral curve system-standard, flat, steep-in order to achieve the ideal edge lift of 0.8mm.

Rose K fitting guide

Step One: Start the trial fitting 0.2 steeper than the average of the K readings. Initial base curve selection should be based on either keratometry or by corneal topography. For topographies, choose a first lens equivalent to the corneal curvature at the 3mm ring, temporal side.

Step Two: If this is a new rigid lens wearer, it may be advisable to use an anesthetic. This quickens the fitting process and allows a more accurate assessment of the fluorescein pattern because of reduced tearing.

Step Three: Too much fluorescein will give false patterns - so be careful when instilling it. Accurate fluorescein assessment is the only method of fitting this lens.

Step Four: Trial fit for the base curve – First assess the central fit. Ignore the peripheral fit at this stage. A light feathery touch at the apex of the cone is best. The rest of the pattern should look as close to alignment fit as possible.

Step Five: Next consider the peripheral fit. The trial lenses have a standard edge lift, but an increased or decreased edge lift on the same base curve can be ordered. If the central base curve looks good but you have inadequate peripheral edge lift, then order increased edge lift. Conversely, order decreased lift if there is excessive peripheral lift.
The peripheral band of fluorescein should be 0.5 to 0.7 mm wide.

**Step Six:** The standard diameter is 8.70mm but any diameter is available. Smaller diameters of 8.10 - 8.30 work well on steep corneas and on highly astigmatic corneas. A larger diameter will tend to make the lens ride higher. Palpebral aperture width also influences the diameter of the lens. For large palpebral apertures, large diameter lenses are required.

**Step Seven:** Do a careful over-refraction using 1.00D steps initially and then refine. If the final over-refraction is greater than 4 Diopeters, vertex distance compensation has to be done.

**Follow-up examinations**

Prior to a follow up examination, the contact lenses should be worn for at least three continuous hours and the patient should be asked to identify any problems related to contact lens wear. Patients should be re examined two weeks after dispensing their lenses. Regular routine six monthly examinations are important for good patient management and successful contact lens wear. Lenses should be re polished at least annually and ideally every six months. Protein removal systems are also prescribed.

**Rose K2 Lens**

The Rose K2 lens was created to address two critical areas of performance for the keratoconic patient - spherical aberration and small optical zones. The base curve of the Rose K2 lens has an aspheric (non-spherical) optical zone unlike the spherical optical zone found on the original Rose K lens. This aspheric optical zone controls spherical aberration found on all contact lenses in higher minus powers, typically present with keratoconus lenses. The incorporation of aspheric optics into the lens design improves vision performance and enhances wearing comfort. The aspheric optical zone is larger than that of the original Rose K reducing glare, haloes and flare, common for many keratoconic patients in dim illumination (night time).

**Rose K2 IC (Irregular Cornea) and K2 Post Graft lenses** are large diameter, reverse geometry, intra limbal lenses (diameters that extends to the outer edge of the cornea), with aberration control aspheric optics for applications in specialty GP lens fitting. Primary applications for Rose K2 IC lenses include: Pellucid Marginal Degeneration, Keratoglobus, Post Graft, and LASIK-induced Ectasia, Post PRK, large oval, sagging cones and patients with irregular corneas due to trauma. Nipple and oval cones, found in some keratoconus patients, are secondary applications.

**ACT (Asymmetric Corneal Technology)**

By nature, the keratoconic cornea is asymmetric, where the inferior Quadrant is frequently significantly steeper than the superior portion, causing the GP lens to lift off at 6 o’clock. Rose K lenses incorporating ACT are designed to accommodate this asymmetry (good edge lift at 3, 9 and 12 o’clock but lift at 6 o’clock). The inferior quadrant of the lens is steeper than the superior quadrants, providing a more accurate fit at 6 o’clock making the lens more comfortable and often providing superior vision.
**Piggyback lenses**

Piggyback lenses are used when the Rose K lens has to be fitted very flat to attain good vision. Fit the Rose K lens 0.3 mm flatter and 0.5 mm larger than if the lens was fitted directly onto the cornea. Use a low minus soft spherical lens carrier which does not hydrate easily. The Rose K lens must move freely over the soft carrier. Always fit flatter than normal to ensure good Rose k lens movement.

**Soft Lenses**

Soft contact lenses have a limited role in correcting corneal irregularity as they tend to drape over the surface of the cornea and result in poor visual acuity. Silicone hydrogel lenses can be relevant here since the increase in rigidity compared to conventional hydrogels helps to mask the astigmatism and silicone hydrogel torics such as Pure vision (Bausch &Lomb) may be successful. However, soft lenses designed specifically for keratoconus such as Kera soft (Ultra-vision) or Soft K (Acuity contact lenses) have a useful role in early keratoconus or where a patient may be intolerant of RGP. They afford higher levels of comfort and longer wearing times.

One custom-made soft lens for keratoconus, manufactured by Flex lens is made of material with 45% water content and can be made in any power or curvature. When high-molecular-weight fluorescein is instilled in the eye of a patient wearing this lens, the fluorescein pattern under the lens is similar to that of a rigid lens. Lens movement is vital for a successful fit. Movement of this lens can be maximized by varying the secondary curve.

Disadvantages of soft lenses are corneal edema and neo vascularisation if the lenses are overworn.

**Hybrid Lens System**

The Soft perm lens (Ciba vision) is a hybrid lens with an RGP centre surrounded by a soft hydrophilic skirt. These lenses tend to be used in cases of RGP lens intolerance or for patients with displaced corneal apexes. There are many advantages to the soft perm lens as it provides better comfort than the RGP lens, better centration and visual acuity. It provides the comfort of a soft lens and visual acuity of a rigid lens.

The Synerg Eyes hybrid contact lenses are the first FDA-cleared hybrid contact lens specifically designed for keratoconus vision correction. Utilizing revolutionary hybrid technology, Synerg Eyes® has developed a family of lenses that provide keratoconus patients with the all-day comfort of soft contact lenses and the excellent visual clarity of rigid gas permeable lenses. SynergEyes contact lenses for keratoconus are custom designed to meet your vision correction needs. There are two different lens designs, SynergEyes® KC, and ClearKone™, to address all stages of keratoconus.

Disadvantages are the frequent breakage, giant papillary conjunctivitis and peripheral corneal neovascularisation.

**Piggyback Lenses**

Piggyback lenses are used in cases of RGP lens intolerance, proud nebulae in keratoconus, apical dimpling and recurrent corneal erosion. The system consists of a rigid lens fitted on top of a soft lens. The aim is to maintain the same level of visual acuity as with a single lens.

The RGP lens should be fitted first. Good centration is important and a slightly larger area of apical touch is usually acceptable as the RGP lens will be cushioned by a soft lens. A silicone hydrogel soft lens should be used where possible, with good movement and coverage/centration as in a normal soft lens fitting.

Caring of the two types of lenses can be difficult long term. The cornea should be observed carefully for dryness and neovascularisation.
Scleral lenses

Scleral lenses play a very significant role in cases of advanced keratoconus where corneal lenses do not work.

The Boston Scleral Lens

Boston Scleral Lens (BSLPD—Boston scleral lens prosthetic device) is a specially designed fluid ventilated gas permeable contact lens device that provides a non-surgical means of restoring vision in eyes affected with corneal disorders. Invented by Dr Perry Rosenthal of Boston, FDA approval was obtained in 1994. The lens is about 18 to 23 mm in diameter and it rests entirely on the sclera and arches over the damaged cornea, thereby creating a space that is filled with normal saline or artificial tears. This fluid reservoir masks the distorted corneal topography and improves vision. It also functions as a unique liquid bandage by protecting the corneal surface from the desiccating effects of exposure to air and the friction of blinking. The presence of corneal oedema is a contraindication to wearing this device. The need to customize and design individual lenses makes these lenses expensive.

Conclusion

Patients with keratoconus are a challenge. A wide range of contact lens designs and materials is available. Contact lens management is often a compromise between the quest for an ideal fit and the patient’s requirements for comfort and best vision. Keratoconics can live a normal life with the help of a good contact lens practitioner.

References

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