CONTACT LENS FITTINGS TECHNIQUES WITH IRREGULAR CORNEAS

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3-19-99

INTRODUCTION

In the practice of optometry, we rarely come across patients with irregular corneas. This leads to some practitioners to lose confidence in their ability to fit these patients. This is very unfortunate because these patients are some of the most highly motivated, and if successfully fit can be very good referral sources for your practice. There are many types of conditions leading to, or causing irregular corneal surfaces that can be treated and managed visually with contact lenses. I will briefly define and explain some of these conditions, along with providing techniques and contact lenses available for successfully fitting these patients.

KERATOCONUS

"Keratoconus is a non-inflammatory, variably progressive thinning disorder of the central cornea."[1] The thinning of the cornea causes an oval or cone shape that can cause irregular astigmatism, steep inferior corneal curvature, and distortion. It is typically seen bilaterally, often asymmetric. It can also have long periods of time where it is stable and then suddenly progresses. The cause of keratoconus is still unknown, "it appears to have a hereditary basis in approximately 8% of cases."[2] Keratoconus has been linked to other systemic diseases such as Down's syndrome, Ehler's Danlos syndrome, Marfan's syndrome, and osteogenesis imperfecta. Experts theorize that mechanical factors can play

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a role in the onset and course of keratoconus. These people feel that atopy and eye rubbing are key factors of keratoconus both of which are commonly found in patient's with Down's syndrome and floppy eyelid syndrome. Early keratoconus patients are typically myopic with astigmatism and can be treated with soft toric contact lenses with good results. "Some keratoconus patients are successful with a soft contact lens that is thick and has a steep base curve."[3] The Flexlens keratoconus lens is a soft hydrogel lens of a 45% Heflicon A material that uses three posterior curves. The central curve fits the cone; a peripheral curve fits the mid-periphery, and lastly a curve to fit the sclera. It is a thick lens with a center thickness of 0.40 mm which allows it to correct most of the irregular astigmatism seen in early keratoconus. Custom toric soft lenses are also helpful in managing early keratoconus, but most patients eventually are re-fit with RGP lenses. Treatment of moderate keratoconus has typically involved rigid gas permeable contact lenses. There are three different fitting philosophies in keratoconus: "apical clearance, divided support/three-point touch, or apical corneal touch."[4] Fitting of keratoconus patients is very subjective due to the different fitting philosophies and the large numbers of contact lens possibilities. Contact lens fitting of early keratoconus (K's <50 D) is usually estimated by taking one-third the difference between the K-readings to make the initial lens selection. For example: if we have K-readings of 42.00 D @ 090; 48.00@ 180 the initial base curve would be 44 D or 7.67 mm. The ideal fluorescein pattern should show slight central touch or slight central clearance, which is typical of a divided support/three-point touch fit. The lens is fit too flat if there is more than 4 mm of apical touch/central bearing. The weight of the lens should bear in the mid-periphery with good

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peripheral curve clearance and no signs of seal off. The contact lens is fit too steep when there is excessive peripheral bearing with bubbles centrally. The most common problem with fitting keratoconus is a steep, low riding non-moving lens, which can lead to arcuate staining, and a lens that seals onto the cornea. Another commonly encountered problem with previous RGP lens wear is excessive apical touch which causes contact lens induced apical erosions. In a study by Rosenthal and Cotter, 68 eyes with keratoconus and recurring contact lens induced central corneal erosions from RGP lenses were refit with apically clearing lenses. The results were as follows, "Apical staining was eliminated in 49 eyes (72%), significantly reduced in 13 eyes (19%), and remained unchanged in six eyes (9%). Corneal abrasion related symptoms of contact lens wear intolerance resolved in 41 of 43 eyes."[5]

Advanced keratoconus (K's 50-56 D) usually have three cone types: nipple or round cone, oval cone, and globus cone. The determination of cone type is best seen by looking at the Fleisher ring, a brown ring of iron deposits in the cornea, a hallmark sign of keratoconus. Dilating the patient and looking at the cone against the red reflex can also help determine cone type.

The nipple cone's initial lens is selected as before by taking one-third the difference between the K's and adding it to the flattest K-reading. The diameter of the initial lens is 8.0 to 8.5 mm with optic zone diameters of 7.0 mm. The ideal fluorescein is divided support/three point touch with slight apical clearance or touch. The patient's VA may be better with the slight apical touch, but slight apical clearance minimizes the chance of central scarring of the cornea.

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The oval cone is the most commonly seen cone type. The fitting of an oval cone is more difficult than a nipple cone. We start with slightly larger overall diameters around 8.5-9.0 mm. with an optic zone diameter of 6.5-7.0 mm. The fitting philosophy is the same as with a nipple cone we desire a 3 point touch fit with the base curve selected as one-third the difference between meridians from the K-readings added to the flattest base curve. In the fitting process we still need to watch for peripheral seal off, inferior edge lift, and bubbles if inferior edge lift is excessive. Flattening of the base curve or decreasing the size of the optic zone diameter will help to alleviate this problem by decreasing the surface area where bubble can form. "Swirl staining and dimple veiling around the base of the cone can occur if the optic zone region of the lens is too large or if the peripheral curve system is to steep."[6]

The globus cone is the least commonly seen and most difficult of all cone types to fit. We recommend larger overall diameters of 9.0-9.6 mm. and larger optic zone diameters of 7.0-7.6 mm. The ideal fitting philosophy is also three-point touch with a slightly larger area of central touch due to the larger cone area. The initial lens selection is still made by adding one third of the difference between meridians to the flattest base curve.

There are also rigid gas permeable lens designs specifically for keratoconus such as the McGuire lens, Rose K lens, and the Soper lens.

The McGuire lens has an optic zone diameter that is 2.6 mm smaller than the overall diameter and has four peripheral curves, which are 0.3 mm wide. The first peripheral curve is 0.5 mm flatter than the base curve. Followed by a second peripheral curve that is 1.0 mm. flatter than the first peripheral curve, the third peripheral curve is 1.5 mm flatter than the second peripheral curve, and the fourth peripheral curve is 2.0 mm flatter than

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the third peripheral curve. The McGuire lens attempts to fit the cornea peripherally to allow for apical vaulting of the central cornea.

The Rose K lens is an 8.7 mm overall diameter lens with center thickness of 0.16 mm or the minimum available. It is a Fluoroperm material lens and is available in any overall diameter with the back optic zone to base curve and OAD relationship fixed. The back optic zone decreases as the curve is steepened and varies with diameter to keep pooling of the tears to a minimum as the cone steepens, maximizing vision. As the diameter is increased so is the back optic zone, and vice versa as the diameter is decreased. The secondary curve widths increase with the increase in the diameter as well. The power of the lens also increases as the base curve is steepened. The Rose K lens is offered in base curves from 5.10 to 7.60 mm with three different secondary curves and in three lifts – standard, increased, and decreased. The lens can be made with a spherical back surface, a full back toric surface, or a toric peripheral only surface. The goal of the Rose K lens is to provide good tear exchange, keep center thickness to a minimum, and maximize the optic area for any base curve used. The fitting of the Rose K lens is very simple. Trial fitting is used by starting with the first trial lens base curve 0.2 steeper than the average of the K readings. A small area of apical touch after flourescein staining is the goal. Next look at the peripheral fit of the lens. If the central fit is good but there is not enough peripheral edge lift you can order an increased edge lift to compensate. The same is true for the opposite situation. If the lens is riding low a larger diameter lens will help the lens ride higher. Last but not least do an over-refraction to determine the proper power lens to order.

The Soper lens design has two peripheral curves with the steeper central curve to fit the cone and the flatter peripheral curve fits the periphery. "The design is based on the theory that the conic area is abnormal only centrally."[7] The Soper lens is fit by varying the overall diameter and optic zone diameter to achieve a three point touch or apical clearance fit.

Troubleshooting is a large part of the chair time with keratoconus patients, and here are a few clinical pearls. Diameter changes are called for in a number of situations. If you have a tight lens horizontally and it lifts vertically try going to a smaller lens. 3-9 staining is usually lessened by decreasing the overall diameter. On the other hand a low riding lens diameter need to be increased to allow the top of the lens to touch the tarsal plate of the upper lid. If we find superior limbal staining, decrease the diameter and/or increase edge lift to loosen the lens. When the patient complains of ghosting due to looking through the peripheral curves increase the diameter and the optic zone allowing better centration and vision. Decreasing the diameter and/or steepening the peripheral curves can easily eliminate excessive edge standoff. Bubbles beneath the contact lens become increasingly common as keratoconus progresses. This may be lessened, by increasing edge lift, flattening the base curves, and/or decreasing the overall lens diameter. If the bubbles persist fenestrations may help, but usually at the expense of the patients visual acuity. Excessive pooling of tears at the base of the cone can also be lessened by decreasing the overall diameter.

The progression of keratoconus sometimes calls for other lens designs if the above lenses do not provide satisfactory vision or fit. A piggyback fit, aspheric lenses, or hybrid lenses such as the Soft-Perm lens may be used to provide functional vision.

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The piggyback lens consists of a soft hydrogel contact lens with a rigid gas permeable lens fit over the top. It is used when patients can no longer tolerate an RGP lens due to overwear abrasions. The soft lens is fit on K. A spherical over-refraction is performed to determine the proper powers. Then keratometry readings are taken while the soft contact lens is on the eye to determine proper base curve for the RGP lens. The piggyback principle allows for better centration of the RGP lens and increases comfort for the patient. The Flexlens piggyback system is a special system consisting of a soft hydrogel with a depression in the front surface to allow for an RGP lens and increase the comfort and decrease lid-lens interaction. The piggyback lens is also recommended for high irregular astigmats, post-PKP patients, post-corneal trauma patients, pellucid marginal degeneration, and Terrien's marginal degeneration. The biggest problem with this lens type is the decreased oxygen transmission and the decreased wearing time.

The Soft Perm lens is a hybrid of both soft and RGP lenses. The carrier lens is a soft hydrogel lens with a central RGP lens. It is not a lens of choice for keratoconus, but is a fairly successful lens with keratoconus patients. The negatives are that it is hard to remove from the eye, and has decreased oxygen transmission due to a low Dk. However, a new lens with higher Dk materials may be available soon.

Aspheric contact lenses are sometimes used in keratoconus because they give better base curve to cornea fit with less lens bearing at the mid-periphery. Variable focus lenses both soft and RGP materials with aspheric designs also can be helpful in the management of keratoconus.

Scleral RGP contact lenses have been around for years but are a relatively new possibility for the management of severe keratoconus. The basic lens design is an anterior and

posterior surface each with a three-curve design. "The three primary curves of the posterior surface are, from center outward, the posterior optic, posterior secondary, and the posterior haptic."[8] Scleral lenses are filled with saline solution before insertion to provide a lacrimal interface. The posterior optic curve acts as a reservoir to improve poor optics from an irregular corneal surface. "Of the three primary curves of the anterior surface of the lens, the radius of the anterior central curve is chosen according to the dioptric power needed to correct ametropia. The zones of the anterior curves are independent of the those of the posterior curves, and their radii are configured to provide minimal lens thickness consistent with optimal lens strength and integrity."[9] The main reason for using a scleral lens in keratoconus is to improve vision for the patient who has an unstable lens or poor centration with an RGP, piggyback lens, or Soft-Perm lenses. Scleral lenses are also called for when the patient is intolerant to their RGP lenses. "Intolerance to rigid corneal lenses may be based on apical erosions resulting from the fragility of the apical epithelium in keratoconus, apical nodules, unstable lenses, or non-specific discomfort."[10] Scleral lenses clear the central cornea and eliminate any contact with the damaged epithelium. The lid sensation felt with RGP lenses is reduced with a scleral lens design, and the corneal epithelium is not exposed to the constant rubbing by the smaller RGP contact lens helping to provided better comfort for the patient. This lens is usually a last resort used before recommending a corneal transplant. Scleral lenses are easier to take care of and handle than soft or rigid contact lenses. Some disadvantages to scleral lenses are they are difficult to manufacture and require a longer time to fit than

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conventional lenses. Also the size of the lens can intimidate patients and the lens can be felt on the sclera.

Keratoconus contact lens fits are challenging, but in almost all but the most advanced cases a satisfactory contact lens fit can be achieved. An over-refraction is a must in these cases to help determine the best vision with the fitting philosophy and lens design. These patients should be followed up on at regular intervals no more than six months due to the unpredictable nature of keratoconus.

POST-PENETRATING KERATOPLASTY (PKP)

The most common indication for PKP surgery is advanced keratoconus patients who could no longer tolerate contact lenses, or had exhausted all contact lens possibilities. Other reasons for PKP include Fuch's endothelial dystrophy, herpes simplex keratitis, corneal scars from trauma, or corneal ulcers. These patients are usually the most difficult to fit with contact lenses. RGP contact lenses are the lens of choice and can provide the best vision as opposed to spectacles by correcting the irregular astigmatism and corneal distortion seen in most post-PKP patients. "Irregular corneal astigmatism occurs in an estimated 25 percent of eyes after penetrating keratoplasty."[11] The lenses are usually well tolerated by the post-PKP patients due to the decreased corneal sensitivity. Rigid gas permeable contact lenses help to "smooth" out surface irregularities by allowing a tear lens beneath the contact lens reducing distortion in their vision.

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"The topography of the cornea after penetrating keratoplasty has been described by Waring, et al. (1992), as one of five major shapes: prolate; oblate; mixed prolate and oblate; asymmetric; and steep-to-flat."[12] The prolate cornea is steep at the center and flat in the periphery. It is best fit with a spherical RGP lens or a specialty keratoconus RGP design if the cornea is steep. The oblate is flatter in the center and steeper in the periphery. "The oblate shape is best fit with one of the reverse geometry lens designs which feature a plateau shape with secondary curves 2.00D to 8.00D steeper than the central posterior curve of the optical zone."[13] A spherical RGP may be used if the astigmatism is low and localized centrally. The mixed prolate and oblate shows a mixed astigmatism topographically of a red bow tie intercepted with a blue bow tie. A bitoric RGP works best due to the saddle fit of the contact lens and correction of residual astigmatism. The asymmetric topographically shows two steep hemi-meridians that are not 180 degrees apart. The steep-to-flat cornea shows the steepest hemi-meridian 180 degrees from the flattest hemi-meridian. Both the asymmetric and the steep-to-flat corneas are difficult to keep an RGP centered so larger overall and optic zone diameters work better. Aspheric designs also work well to help center the lenses as well. Post-PKP patients are not fit with contact lenses right away. The corneal transplant patients have prolonged healing time and usually cannot be fit with contact until about six months to one year after the surgery. Contact lenses can be fit even with sutures still in the cornea, but they need to be buried. It is important to examine the sutures for swelling before fitting of contact lenses. Exposed sutures provide a good deal of irritation to the patient, and contact lenses could increase irritation. Soft contact lenses can used as bandages with

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exposed sutures. Spherical base curves and large diameter RGP lenses are needed. Start around 9.0-9.5 mm. with large optic zones around 7.5-8.0 mm., and some lenses can be as large as 10.5 mm with and OZD of 9.0 mm. Aspheric or biaspheric designs are used if there are problems with decentration and excessive bearing with the spherical lenses. Some patients may have a flat central cornea with a steeper periphery making the fit difficult with the above lenses and back surface toric designs. The Conforma's RK Bridge lens is a good option for these patients. The lens was originally designed for patients who needed correction after RK (Radial-Keratectomy) refractive surgery. These patients are flatter centrally and steeper in the periphery. The Quintasphere PK post-graft contact lens is designed specifically for the post-PKP patient. It has a central base curve with four peripheral curves for providing a shape similar to the normal peripheral cornea. Two fitting sets are available one with an overall diameter of 9.5 mm and the other with an overall diameter of 10 mm. Both sets have base curves from 6.49 mm (52.00D) to 8.03 mm (42.00D) in 0.75D steps. The Quintasphere lenses are made of Boston RXD flurosilicone acrylate with a Dk of 45. The fitting process is best performed empirically using trial lenses and evaluating the fluorescein patterns. The ideal fit is with the smallest lens that provides the best fit to minimize the weight on the cornea. It is very common for these lenses to de-center. If the decentration becomes a problem a Soft-Perm lens can be used. The SoftPerm lens provides excellent centration and lens stability, but watch for neovascularization due to the low oxygen transmission of the lens. The visual acuity from a SoftPerm lens is better than a soft lens, but not as good as an RGP lens. The SoftPerm lens has also shown a tendency to tighten on the eye and being difficult to remove. Also over time the RGP portion has a tendency to separate from the soft skirt.

A piggyback lens system can be used only as a last resort due to poor oxygen transmission through the combination of lenses. The soft lens base curve is chosen to match the topography of the graft. In a flat graft, the flat central cornea is filled in using a plus rigid gas permeable lens. In a protruding graft a thin high minus lens provides the best vision. The soft lens is inserted first and then keratometry is performed over the lens for choosing the correct base curve of the rigid gas permeable lens. It is important to find a lens with good centration and even bearing. The biggest problem for the patient's with a piggyback system is care. The patients have two different care systems for the two different lenses, which doubles their time and chance for non-compliance.

The fluorescein pattern seen in post-PKP patients is very irregular due to the irregular surface, but the patient's vision should be correctable to 20/20 to 20/40. Flat fitting lenses give the best VA's. If bubbles become a problem flattening the base curve or making the optic zone diameter smaller lessens the problem. The ideal contact lens is one that bears its weight as evenly as possible over the corneal surface. Some lens-induced staining is usually acceptable in these patients provided that it is small, diffuse, and resolves quickly after the contact lens is removed. A very important factor to consider in fitting contact lenses for these patients is oxygen transmission and the amount of tears. The corneal transplant may have a compromised corneal endothelium, so a higher Dk lens is called for in these cases. The tears are important in fitting RGP contact lenses in that they help smooth out the irregular surface and allow comfortable fitting with less chance of the contacts bearing and causing erosions. Adequate tears help provide proper lens movement and oxygen to the cornea.

Some patients may have regular topography and if they are sensitive to the RGP lens they may be fit with a spherical or toric soft lens. Keratometry is useful in these cases, the mires should not be distorted and if significant cylinder is shown a toric lens is indicated. If soft lenses are worn they need to be of a high oxygen permeable material.

Scleral lenses are also another possibility for the post-PKP patient. The main advantage of scleral contact lenses in these patients is the correction of severe irregular astigmatism. Scleral lenses also allow for better centration and vision with less lid sensation for high powers than corneal lenses. Simply using a steeper base curve, or using a larger diameter lens lessens punctate fluorescein staining due to a flat fitting lens. Sometimes this can exacerbate the problem by lessening the bearing area but increases the weight on that area. In this case, flattening the base curve helps to achieve a more even distribution of the contact's weight.

Flattening the lens, taking some weight off of the periphery and distributing it to the central cornea lessens peripheral staining. Increasing the diameter of the lens also lessens the weight in the periphery by distributing in further out in the periphery.

If poor vision is a problem due to irregular topography and astigmatism, flattening the lens can increase VA's but be careful not to increase central bearing an excessive amount which can lead to scarring over time.

It is key to watch for signs of graft rejection in these patients. Graft rejection can occur in the epithelium or the entire cornea. Epithelial rejection is the least serious and presents as elevated line across the entire cornea and may progress to endothelial rejection if left unchecked. Treatment for epithelial graft rejection is topical steroids. Endothelial graft rejection produces corneal edema and stromal thickening. Keratic precipitates and an

anterior chamber reactions are almost always present. Systemic or subconjunctival steroids are usually the treatments of choice for endothelial graft rejection. "Signs of corneal rejection include pain, injection, tearing, ocular discomfort, and reduced vision."[14] Patient education of the symptoms of graft rejection is essential in order to treat the rejection as soon a possible to avoid serious vision loss. The Graft neovascularization is also an important sign to watch for in the contact lens wearing post-PKP patient, it signifies a decrease oxygen level in the area.

Contact lens fittings of the post-PKP patient can be time consuming and frustrating, but the rewards are many including a happy patient that is a great source of referrals for your practice.

POST-REFRACTIVE SURGERY (RK, PRK, AND LASIK)

Radial keratotomy is a surgical procedure to correct myopia and astigmatism performed by making radial cuts in the peripheral cornea to flatten the central cornea. Many patients who have undergone this procedure are still left under or over-corrected and need contact lenses to achieve optimum visual acuity. The challenge with these types of patients is that contact lenses are designed for corneas that are steeper in the center than the periphery, not for the centrally flat corneas and steeper peripheries seen in the post-refractive surgery patient. Most contact lenses do not center well with these patients and usually move superior nasal in the eye. This leads to the most common complaint of increased flare and glare. Flare and glare is also the most common complaint in early

post-op RK patients, but usually decreases over time as the incisions heal. This contact lens related complaint is corrected the same as in a non-surgical patient, by increasing overall diameter, optic zone diameter, or both. If increasing the OZD and OAD don't work try switching to an aspheric design lens. Aspheric lenses work by eliminating the peripheral curve junctions found in spherical lenses. Aspheric lenses can also be used to help center the lens if increasing the overall and optic zone diameter does not help. If fitting an aspheric lens on a post-RK patient choose a base curve steeper than a standard spherical lens. "For example, a 0.65 eccentricity value aspheric lens should be fitted about 1.75D steeper than a spherical design to achieve the same alignment fluorescein pattern."[15] Prism ballasted lenses can also help to center a high riding lens. When fitting these lenses you must have the proper amount of movement to allow for good tear exchange between blinks. If there is lack of movement the oxygen level drops, which can lead to neovascularization of the cornea. Fitting of these patients usually consists of using a large diameter spherical RGP lens to vault the flatter central cornea. The base curve used is the flattest pre-operative K-readings of the cornea. Typical slit lamp examination shows a superior and nasal fitting contact lens. If the lens is centered, an excessive central pooling of fluorescein is expected and bubbles beneath the lens are not uncommon.

The goals of fitting of a post-RK patient should be the same as a non-surgical contact lens wearer. "There must be good centration with adequate tear interchange, minimal bearing on any of the cornea, and adequate (1 to 2mm) lens movement following the blink. The visual acuity should be crisp and stable."[16]

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Another special consideration for the post-RK patient is oxygen permeability, due to the compromised nature of the cornea. "Lenses in the Dk range of 28 to 60 are preferable because of their high oxygen permeability and good material stability."[17]

Soft lenses may be used in post-RK patients who can no longer tolerate RGP lenses. These lenses should be used only with extreme caution due to the possibility of neovascularization of the incisions. The soft lenses should be fit with sufficient movement to allow for tear exchange. Fluctuating vision is a sign that the lens is excessively vaulting the central cornea, or moving excessively. When fitting a spherical soft contact lens on a post-RK patient choose the flattest base curve that still allows the contact lens to remain on the cornea.

The Soft-Perm lens is another option, but must also be used with care due to the high incidence of neovascularization of the incisions. The Soft-Perm lens has a low oxygen content skirt and a low Dk center that does not allow adequate oxygen permeability. The lens also has a tendency to tighten during the course of the day, which can lead to corneal hypoxia and neovascularization. If fitting the Soft-Perm lens choose a base-curve close to the mid-peripheral curvature.

There can be complications similar to a "normal" RGP wearer such as 3-9 staining which can be remedied by changing the edge shape and edge lift. Changing to a smaller lens will help as well but usually results in a poorly centered lens.

Poor tear exchange is another possible complication that can induce corneal edema. You can loosen the fit by decreasing OZD and OAD, as well as changing to a higher Dk material. The incisions also create problems for these patients; occasionally they are raised and stain with flourescein dye. In this situation the contact lenses need to be

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removed until the scars have flattened because bearing may cause an epithelial erosion and lead to an infection.

There are a few specialty contact lenses to help maintain centration for the post-RK patient. The Plateau lens by Menicon is a reverse geometry lens which has a flat central curve and with steeper secondary curves with standard peripheral curves. "The central curve selection is based on the flattest post-operative K-reading, whereas the secondary radius is fitted to the flattest pre-operative K-reading. The overall size is usually 10.0 mm with an 8.0 optic zone diameter."[18] Another reverse geometry lens is the OK lens designed for orthokeratology. The OK lens design also has a flat central curve with steepening in the mid-periphery. The Flexlens Harrison PRS Design is another lens for the post refractive surgery patient. "Design features include: a thicker central optic zone to provide more stable optics over the flatter central cornea; a peripheral lens design which is as thin or thinner than a standard soft lens to optimize oxygen transmissibility to the peripheral corneas; and two materials with different water contents (45% and 55%), which can be manufactured in base curves from 6.00mm to 9.90mm, powers from –30.00D to +30.00D and diameters from 10.0mm to 16.0mm."[19]

PRK is a refractive procedure to correct myopia and mild to moderate astigmatism by using an argon fluoride eximer laser to remove corneal epithelium. The fitting of contact lenses on post-PRK patients is not as difficult as fitting contact lenses on the post-RK patients. In PRK the flattening of the cornea by the eximer laser creates a smooth blended transition between the periphery and mid-peripheral cornea while RK creates a sharp junction between the peripheral and central cornea.

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The study of fitting the post-PRK patient by Austin, Gartry, and McG Steele found that, "The best fit rigid gas permeable lens of diameter 9.2-10.0 mm was generally 0.10 mm steeper than mean keratometry readings.[20]" The lenses were chosen to vault the central cornea creating a plus tear lens, and were of a aspheric design to distribute the weight of the contact lens evenly and to prevent sealoff of tear exchange from the midperiphery. The ideal RGP fit is best achieved with centrally steep lenses with alignment in the midperiphery and clearance in the periphery.

Soft contact lenses are tolerated better by post-PRK patients than post-RK patients mainly due to the smooth transition from the periphery to the central cornea due to the accuracy of the laser. "A 14.00 mm diameter soft lens was chosen of medium to high water content for good oxygen transmissibility and the 'first choice' lens had a BOZR radius of curvature 0.30 mm (1.50 D) flatter than the flattest keratometry readings.[21]" It should be noted that the Austin, Gartry, and McG Steele study consisted of patients with a mean ablation zones (treated areas) of 4.5 mm which is significantly smaller than today's ablation zones of 7-8 mm. The larger ablation zones make for more difficult fits and call for custom soft lenses and larger RGP lenses to provide the optimum vision.

LASIK (Laser Assisted in Situ Keratomileusis) is now the most preferred refractive procedure due to it's faster healing and increased patient comfort over PRK immediately after the procedure. There have been few articles on fitting contact lenses post-LASIK mainly due to the success and recentness of the procedure. However, as the procedure becomes more popular the number of unsuccessful surgeries will increase. Some patients may not opt for enchancement creating a need for contact lenses and spectacles. The

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vision is relatively stable approximately four to six weeks after the procedure allowing for a soft contact lens fit. If RGP lenses are to be fit it is best to wait at least eight to twelve weeks in order for the cornea to withstand the trauma of a moving RGP lens. There is currently only one soft lens designed and approved by the United States FDA for the correction post-refractive surgery patients with oblate shaped corneas. The Harrison Post Refractive Lens is approved for patients after RK, PRK, and LASIK. The lens functions like a reverse geometry lens with a flatter central area than in the midperiphery. Soft toric lenses may also be used in these cases but are usually not successful due to excessive movement caused by the flat central cornea.

"The lens of choice-after LASIK-is an RGP lens, because of material rigidity, availability of high oxygen transmissibility, removal of corneal by-products and tear debris through efficient tear exchange, and neutralization of corneal irregularity through the formation of a posterior lens pool."[22] A superior lid attachment with a superior or central position is the most desirable fit. The RGP lens fitted correctly will create a central plus tear pool requiring a significant amount of minus to compensate for best corrected acuity. The ideal flourescein pattern is central pooling "with 1- to 2-mm wide bands of midperipheral bearing."[23] Fitting of the RGP lenses are taken by selecting an initial base curve that is 0.5 to 1.0D flatter than the flattest pre-operative K-reading. If pre-operative K-readings are not available select an initial base curve that is at least 1.0 to 1.5D steeper than the flatter post-operative K-reading. "Common diameters range from 9.2 mm to 10.5 mm, with optical zones ranging 1 to 4 mm smaller than the overall diameter, depending on the

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surgical optical zone and lens design."[24] The lenses optic zone diameters need to be large enough to vault the LASIK optical zone, and provide full pupil coverage in low light conditions.

Reverse geometry lenses are another option for the post-LASIK surgery patient. These lenses are RGP lenses which have secondary curves which are 3 to 6D steeper than the central curve. The reverse geometry lenses help prevent excessive tear pooling and increase lens stability. Some popular reverse geometry lenses are The Pleateau lens, The OK series orthokeratology lenses, The R-K Bridge lens, and the NRK lens.

As we see more and more post-refractive surgery patients there will also be an increased need for fitting contact lenses on these irregular flat central corneas. I feel that the number of these patients will be small but as we see refractive errors drift over time and as presbyopia becomes a factor these patients will most likely desire contact lens correction over spectacles. By planning ahead and knowing how to fit these patients you can create a sub-specialty within your practice.

Patients with irregular astigmatism are in need of our help to maintain their visual acuity and nothing can be more frustrating than being unable to help a patient. Overall, almost all patients with various conditions can be fit successfully with contacts. The single largest factor pointing to success or failure of contact lens wear is patient motivation. Patient education by a qualified and knowledgeable optometrist is key as well as patience during the fitting process. With this in mind I feel that there is a wealth of resources available to the private practice optometrist in order to successfully fit the irregular cornea.

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