LEARNING DOMAINS

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Fitting the irregular cornea

By Martin Conway FBDO, FIACLE, FBCLA

Fitting the irregular cornea is a challenge for both experienced and novice contact lens practitioners. However, it allows the practitioner to fully exercise their skills to provide a life-changing remedy for their patient that is often lacking in the day-to-day supply of contact lenses. In this article, the types of contact lenses available will be briefly described, along with the fitting techniques required to achieve the desired outcome.

It is important that dispensing optician colleagues, who may not be involved in fitting contact lenses, have an understanding of the conditions involved and the types of lenses available to correct them. This article will not delve too deeply into the complexities of each type, but look to inform practitioners of the options open to their patients.

The main causation of an irregularly shaped cornea is keratoconus. Other conditions may also result in the cornea being misshapen. They include pellucid marginal degeneration, corneal transplantation and, more recently, corneal ectasia following laser surgery for the correction of refractive myopia. The fitting of contact lenses to the keratoconic eye will be mainly discussed, as the principles outlined apply to other causes of irregularity.

PREVALENCE

Traditionally, it was always assumed that the prevalence of keratoconus, the principal cause of irregular corneae, was approximately one in 2,000. Recent information from a mandatory health insurance database from the Netherlands indicated that the prevalence in the general population is five to 10-fold that which was previously supposed[1]. A figure of close to 265 cases per 100,000 is more realistic.

The increased use of topography in the Netherlands, rather than traditional keratometry as here in the UK, is probably the main reason for the disparity. The true origins of the one in 2,000 figure are lost in the mists of time but, as topographers increasingly replace the keratometer in UK practices, we can expect a figure closer to that found in the Netherlands to be anticipated for practitioners in the UK. It is realistic to assume that a practitioner will come across keratoconus more frequently than they might have assumed.

CORNEAL CROSS-LINKING

New cases of keratoconus diagnosed in the UK are increasingly being offered corneal cross-linking (CXL) as a primary treatment for the condition. CXL is a treatment to arrest the progression of keratoconus rather than to cure it. This is why early diagnosis is important.

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During the treatment, riboflavin eye drops (vitamin B2) are dropped onto the cornea and, after a short period of time, UV light is applied to the cornea and the riboflavin molecules become cross-linked to the collagen strands within the stroma, improving existing cross-linking, strengthening the cornea and thus preventing future progression of the cone.

The corneal epithelium is impervious to the drops and is, therefore, abraded prior to the treatment. This can be done mechanically, or sometimes using a laser to disrupt the corneal surface. Riboflavin is toxic to the single cell layer of the endothelium, hence the time between application of the drops and use of the UV to trigger cross-linking is of crucial importance in the procedure. Enough time is allowed for the riboflavin to absorb into the stroma, but not long enough for it to reach the endothelium and cause harm. This is critical in cases where corneal thinning is severe. Typically, a time of 15 to 30 minutes is permitted to allow the riboflavin to absorb into the stroma. The precise time is calculated according to the individual's corneal thickness. Novel formulations are allowing even faster absorption

A clinical study at Moorfields[2], in 60 keratoconus patients aged 10 to 16 years, found that cross-linking was effective at stopping progression in young patients.

Early diagnosis, as with any disease process, is essential for a better outcome and, as CXL is now becoming the gold standard in preventing the progression of keratoconus, it is important that all General Optical Council (GOC) registrants are aware of the importance of early diagnosis and referral.

INSTRUMENTATION

The topographer is the instrument of choice for both initial diagnosis and the fitting of lenses to the irregular cornea. In the past, practitioners have obtained good results using their experience in reading fluorescein patterns, but here in the UK the fitting of conventional gas permeable (GP) lenses has declined over the past decades.

Most younger practitioners have not had sufficient exposure to GP wearers to accumulate the skills required to rely upon fluorescein patterns alone. Most practices in the UK will now have ocular coherence tomography (OCT) instrumentation and this, although not essential, makes accurate fitting of scleral lenses achievable for even the novice fitter.

For any practitioner, probably the best advice the author can offer is not to attempt this type of fitting on your own. All labs have very experienced professionals available to assist at every stage of the procedure. Modern technology allows you to share topography data, even fluorescein images, with the professional services team at the lab, who will guide and advise you throughout the fitting process.

Forewarn the patient that this is going to be a process that will require multiple visits. There is nothing worse than a patient who bales out of the process after you have spent time and effort, and feel that you are close to success. This advice applies equally to all the products described in this article and does not change with time. Even experienced practitioners will still discuss their findings and observations with their chosen lab before committing to an initial fit or amendment.

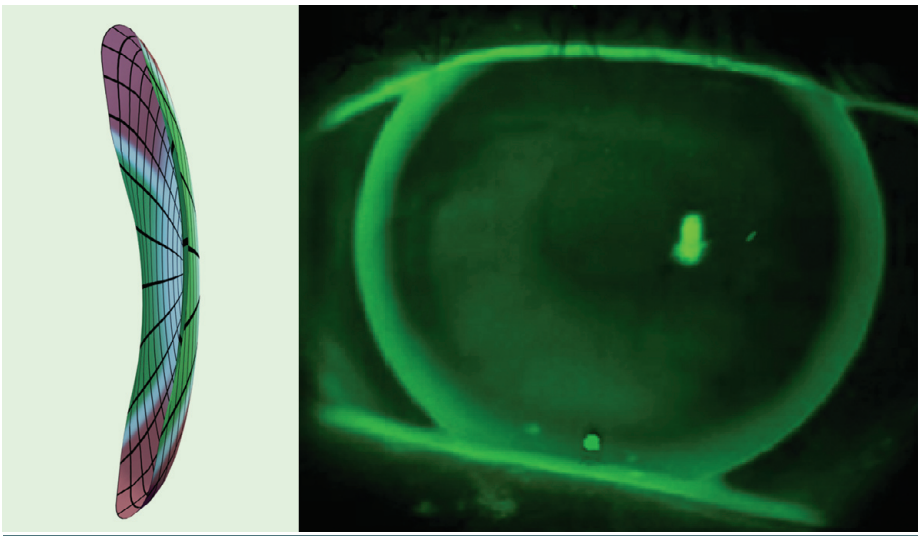

FIGURE 1: ***LEFT: graphic representation of quadrant specific design. RIGHT: ideal fit for a regular cornea*** *(courtesy of Menicon)*

GAS PERMEABLE CONTACT LENSES

For years, the lens of choice in most hospitals and specialist practices for the correction of the irregular cornea has been corneal lenses. Earlier lens attempts had used scleral lenses made from poly methyl methacrylate (PMMA), but the lack of oxygen transmission through the material, coupled with the total coverage of the cornea, meant that once the cornea had used up the supply of oxygen dissolved in the saline trapped under the lens, anoxia symptoms limited their wear to around three hours.

Early corneal lenses still used PMMA as it was the only material available, but this time the cornea was only partially covered, and the movement of the lens under the effect of the lids produced the so-called 'tear pump' mechanism that supplied freshly oxygenated tears under the lens. These lenses had extremely steep back central optic curves to vault the cone. The peripheral curves were similar to that required for a conventional cornea, however, as that area was unaffected by the ectasia.

Lens designers incorporated a series of flattening curves to link the steep central curve to the peripheral curves and avoid too sharp a transition that might cause pressure on the cornea. These junctions were then blended to remove any sharp edges. Even with a skilful fitter, patients had to build up wearing time and tolerance to the lens over a period of weeks, increasing wearing time by as little as half an hour per day to avoid over-wear symptoms that would set them back.

Modern instrumentation, lathes and, most importantly, GP materials have vastly improved the successful fitting of GP lenses for both keratoconic and regular cornea patients. Aspherical curves replace the sharp junctions for a smoother landing at the periphery, and modern lathes can now offer a quadrant-specific design option whereby the practitioner can request that the lens be tighter or looser in one or more meridians to reduce lid sensation in any particular quadrant (**Figure 1**).

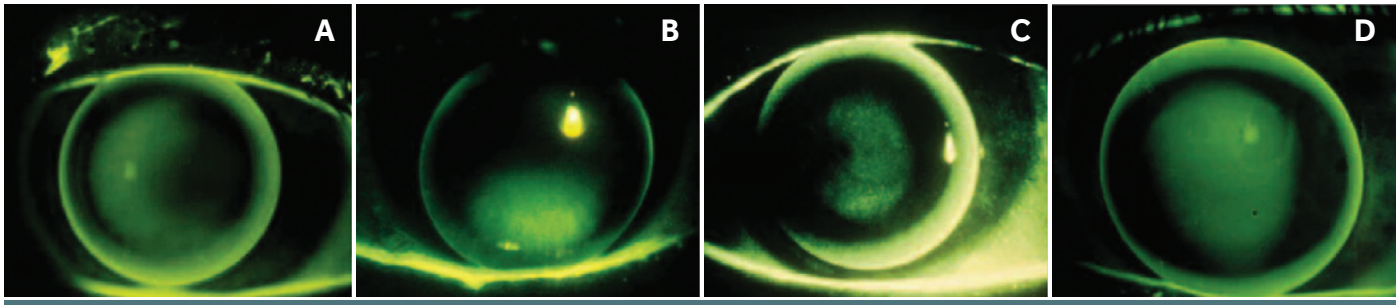

FIGURE 2: ***Rose K2 fitting guidance. L-R: A) Optimum fit immediately after blink; B) Optimum fit a few seconds after blink. Don't judge fit in this downward location; C) Good fit centrally – loose peripherally; D) Steep centrally – good fit peripherally*** *(courtesy of Menicon)*

Modern materials mean that the lens now transmits oxygen directly to the cornea underneath, thus reducing the need for excessive movement and permitting larger diameters to be utilised, both of which improve comfort.

Designs of lenses such as the ubiquitous Rose-K family have evolved to include designs specifically for the emerging cone, with a central 'nipple cone', designs for post-graft and irregular cornea patient alongside the more traditional keratoconic design (**Figure 2**).

Initial fitting is done using a comprehensive fitting set. Central Ks are of little use and although some fitting guides may offer suggestions as to what the initial lens should be, the practitioner should be prepared to use a number of lenses before settling on a given base curve.

Both for the patient's comfort and to reduce tearing, the use of anaesthetic drops is fundamental to get an accurate assessment of fit. The aim initially is to provide a slight central clearance. It used to be recommended that a 'feather touch' be achieved, however, the author disagrees with that philosophy. It is difficult to achieve and invariably results in central abrasion, which can lead to scarring, particularly in a progressing cone. It may have been theorised that touch would somehow constrain the progression of the cone. That, in the author's experience, is not the case.

Once the ideal central curve is established, the attention of the fitter should be addressed to the periphery. This can be raised or lowered as necessary to give as close to the ideal picture as possible, normally in numerical steps. Again, consultation with the lab by sharing images from the slit lamp is essential for the inexperienced practitioner. These can be collected using a smartphone if a slit lamp camera is not available.

The benefit of obtaining these images also means that the practitioner can study them after the patient has left the consultation room rather than have to assess the fit of a constantly moving lens in situ producing a rapidly changing picture. Remember: general data protection regulation issues do need to be considered and managed if using a smartphone to obtain patient images.

Most fitting guides will include images of an ideal fitting pattern, together with both flat and steep fluorescein imagery for comparison.

SOFT CONTACT LENSES

For the practitioner with limited experience with GP lenses, soft contact lenses can be an attractive solution for the problems associated with correcting the irregular cornea. In the early stages, good results may be obtained using moulded toric lenses, but as corneal toricity becomes more irregular, a conventional moulded lens cannot mask the underlying shape of the irregular surface.

Soft contact lenses designed for the correction of keratoconus and other irregular corneal conditions use increased central thickness to mask the underlying irregularity and then correct any regular astigmatism remaining with a toric front surface.

Typically, early designs had a central thickness of 300 microns, which is double that of a conventional lathe-cut soft lens. Doubling the thickness will invariably reduce oxygen transmission by half. That is why it is advised to use a silicone hydrogel material, such as Definitive 74 which has a Dk of 60, to maintain as much oxygen flow through the lens to the underlying cornea.

Doubling the central thickness does not simply double the stiffness of the finished lens. Unlike oxygen transmissibility, which is inversely proportional to the thickness of the material as in Dk/t, the flexural modulus of a material increases by the cube of the thickness. Doubling the thickness results in an eightfold increase in stiffness – and that is the secret of how these lenses work.

The best known of these lenses in the UK is the Kerasoft design from UltraVision. Like the Rose-K lens, the design has evolved over time, and the original Kerasoft design has now been joined by a thinner, more flexible version – the Kerasoft Thin – with a 200 microns centre thickness to improve oxygen transmission and comfort.

Complete fitting instructions are included in the fitting guide, and an online calculator assists with selecting the first choice of lens. Because of the high cylindrical corrections involved, the stability of the lens is of paramount importance.

It is highly recommended that the new practitioner follows the guide and, again, liaises with the professional services team. The author recommends that soft, dedicated irregular cornea design contact lenses are suited to the emerging and early cones – and for practitioners more familiar with soft lens fitting than GP lens fitting.

HYBRID CONTACT LENSES

For many years, it was the dream for a manufacturer to come up with a lens design that could combine the comfort of a soft contact lens with the superior optical performance of a GP lens. The ideal solution was, therefore, the hybrid lens: a soft lens with a hard centre.

Early attempts at fusing the two types of material were less than satisfactory with lenses splitting on eye, causing all sorts of issues. More recently, however, two companies appear to have solved the problem. SynergEyes from the USA and LCS in France have both developed successful new variants of the original concept. They both now offer a silicone

skirt and a high Dk GP central optic, but use different materials and fitting philosophies to achieve their goal. Both have overcome the early issues with this type of lens, yet they differ in their approach to fitting.

SynergEyes uses a technique for fitting the irregular cornea with hybrid lenses which is similar to that used in scleral fitting (to be discussed later). It is based on sagittal height rather than a central curvature, and incorporates reverse geometry to help achieve clearance.

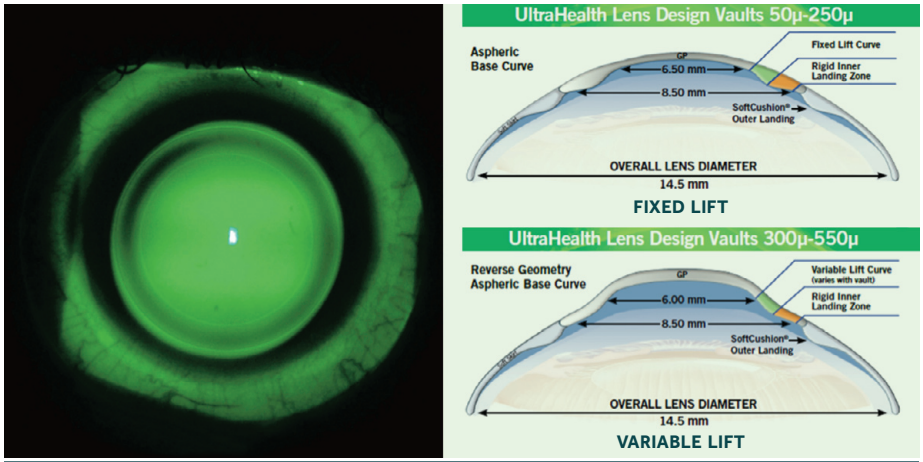

FIGURE 3: ***UltraHealth Hybrid lens by SynergEyes*** *(courtesy of SynergEyes)*

Typically, a 250 micron vault lens is applied and the central clearance is assessed using regular fluorescein (**Figure 3**). If no touch is observed, then the lens is removed and replaced with one of a lower height until touch is observed. This lens is then replaced by one a step higher, thus achieving just enough clearance without creating too much. Too much clearance can cause the lens to adhere to the cornea, which is alarming for both the patient and the practitioner. The curvature of the silicone hydrogel skirt is then assessed and can be adjusted as required.

This is a time-consuming procedure that must not be rushed, however, it can produce the desired effect of excellent vision and comfort akin to that of a soft lens. Alternatively, with the appropriate topographical information, these lenses can also be designed empirically with efficient precision and first-time success.

The LCS product, known in France as Eyebrid and manufactured in the UK under license by No7 Contact Lenses as Elements, uses a different philosophy. Initial fitting is done from the practitioner's current fitting set, which means that the practitioner does not have to learn a new product's idiosyncrasies. It is particularly useful when fitting an existing GP wearer whose fitting and vision are optimal, but wishes to improve comfort. It means that the existing parameters can be incorporated into the Elements lens with no fitting set required. The prescription lens is supplied with a standard skirt, which may be adjusted if required, which, in the author's experience, is rarely needed.

Both products require a slightly different approach for handling, particularly for removal, and both products have tremendous potential which will probably unfortunately never be fully achieved due to the untimely explosion of interest in fitting scleral contact lenses.

SCLERAL CONTACT LENSES

Over the past 10 years, scleral contact lenses have grown in popularity as a lens of first choice for fitting the irregular cornea. Once the province of specialist fitters in hospital clinics, the growth of interest in fitting this type of lens has been spurred on by innovative designs made possible by the use of OCT instrumentation. We can now see in detailed cross-section exactly how much clearance is required over the cornea, and exactly what shape the landing portion of the lens needs to be to perfectly align with the sclera.

Scleral lenses themselves are fairly simple designs. They do not touch the cornea, but vault the entire irregular expanse and come to land on the very forgiving, spongy surface of the sclera. This means that they can be fitted and give good results by an inexperienced practitioner.

Insertion and removal techniques are less patient-friendly than some of the other lens types discussed but, once mastered, most patients find them surprisingly comfortable and the vision is normally excellent.

The fitter has just three areas of adjustment to concern themselves with: 1) the sag height, which is determined by the clearance over the highest point of the cornea, normally the cone; 2) the landing zone angle, whether it is aligned with the sclera or needs to be raised or lowered; and 3) the transition zone between these two.

Some designs use a reverse curve to ensure no touch at the limbus, others suggest a more closely aligned transition. All of these may be assessed using fluorescein (**Figure 4**), but in the author's experience, it is far more accurate and simpler to use OCT (**Figures 5-7** see over).

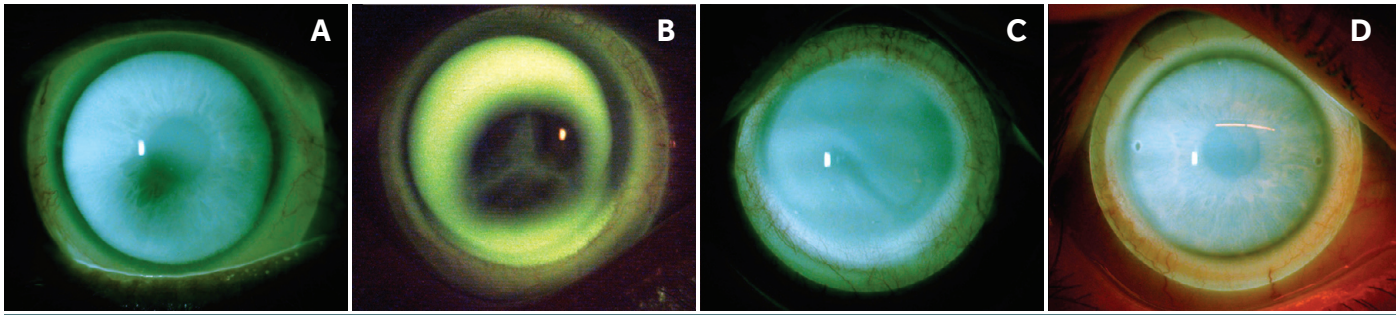

FIGURE 4: ***Evaluating SAG using fluorescein: example L-R: A) Light touch; B) heavy touch; C) excessive apical clearance; D) ideal sag***

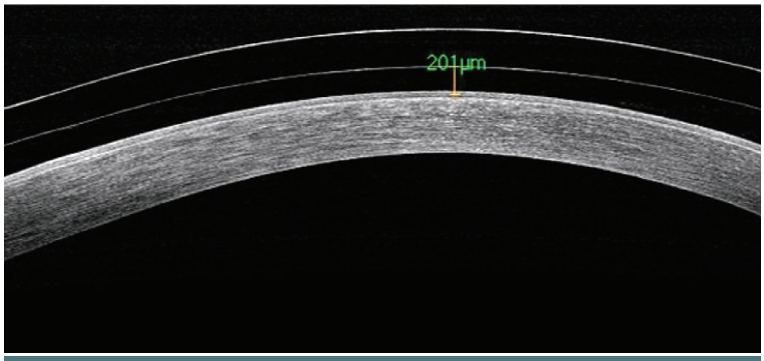

FIGURE 5: *Scleral contact lens with clearance measured using cursor*

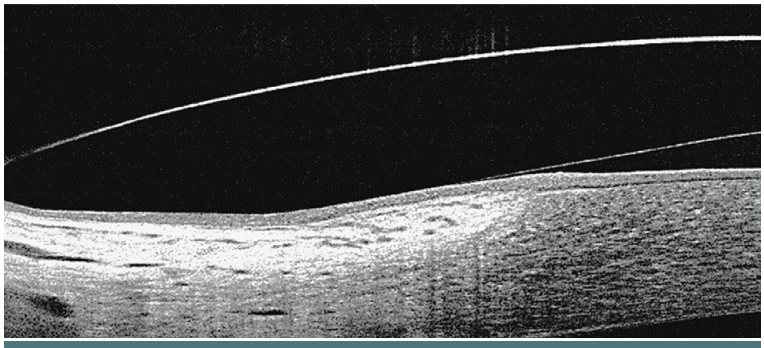

FIGURE 6: *Traditional scleral edge design*

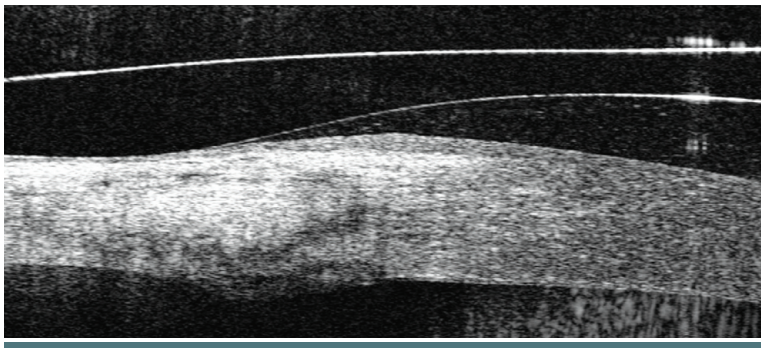

FIGURE 7: *Reverse curve scleral edge design*

CONCLUSION

Fitting the irregular cornea may appear challenging initially, but is a rewarding experience for both practitioner and patient. A topographer should be seen as an essential piece of equipment for the practice that intends to develop its contact lens business to include specialist contact lens fitting and dry eye treatment as part of its offering.

For the inexperienced practitioner, the author would recommend that they contact their preferred laboratory and discuss their requirements. Most labs will offer training courses in-house, and some will offer a practice visit from an experienced fitter to assist with initial fits. Ongoing communication with the professional service teams at laboratories helps build relationships that can grow throughout your career.

ABDO has been offering a Scleral Masterclass at the National Resource Centre this year; both sessions to date have been fully booked and feedback has been very encouraging.

REFERENCES

1. Godefrooij DA, de Wit GA, Uiterwaal CS, Imhof SM and Wisse RPL. Age-specific Incidence and prevalence of keratoconus: a nationwide registration study. *American Journal of Ophthalmology* 2017 175:169-172. ***doi:10.1016/j.ajo.2016.12.015.***

2. Moorfields. Corneal cross-linking is effective in treating young keratoconus patients. 2021. Available at: ***https://www.moorfields.nhs.uk/news/corneal-cross-linking-effective-treating-young-keratoconus-patients***

MARTIN CONWAY FBDO, FIACLE, FBCLA has more than 40 years' experience in the contact lens field as a qualified contact lens optician. He is registered with the GOC on the Speciality Contact Lens Register. He is a fellow of both the British Contact Lens Association and the International Association of Contact Lens Educators. He was general manager for Barnes Hind/Hydrocurve, has served in a professional services role as an educator and clinical adviser for Sauflon and CIBA Vision, and now acts as professional services consultant for Contamac. He has lectured extensively in Europe, Asia, Russia, North and South America and the Middle East. Martin still practises, specialising in fitting irregular corneae.

LEARNING OUTCOMES FOR THIS CPD ARTICLE

DOMAIN: Contact lens speciality

Develop a greater understanding of the contact lens options available to support patients with irregular corneae and the varying fitting approaches. Additionally, consider when referral for corneal cross-linking may recommended for patients with keratoconus.

DOMAIN: Clinical practice

7.5: *Provide effective care and treatment for patients with irregular corneae based on current good practice.*

DOMAIN: Communication

1.3: *Support patients with irregular corneas to make informed decisions about their care.*

2.2: *Provide patients with irregular corneas information regarding possible contact lens management options and processes and about referral for corneal cross-linking where relevant.*