

Keratoconus – 1

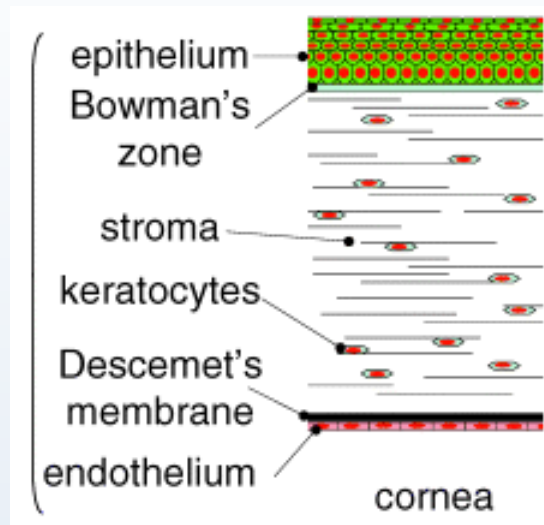
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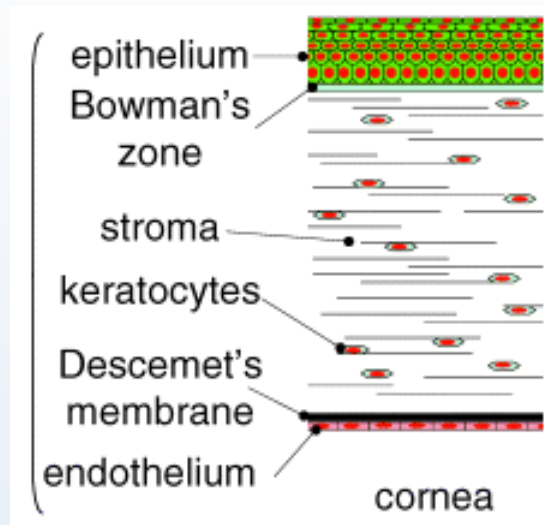
Dip Oc Therapeutics Dip Humanities (Music)

What Is Keratoconus?



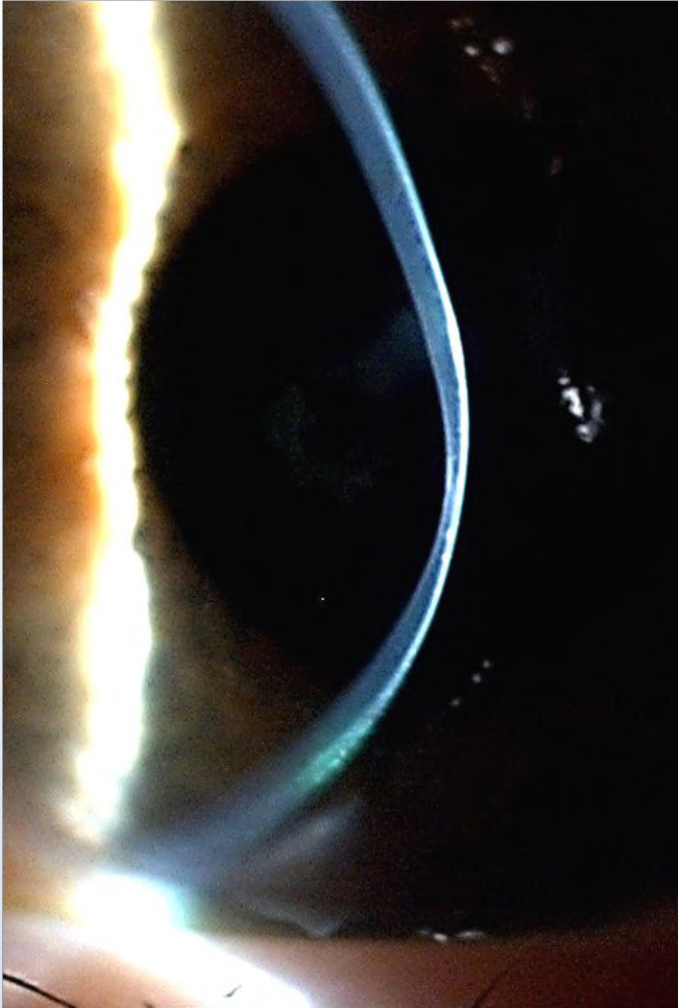
- Keratoconus is a condition in which the cornea assumes a conical shape as a result of non-inflammatory thinning of the corneal stroma (90% of corneal thickness)
- Keratoconus is the most common corneal ectasia
- Progressive stromal thinning allows the IOP to distort the corneal shape

What Is Keratoconus?



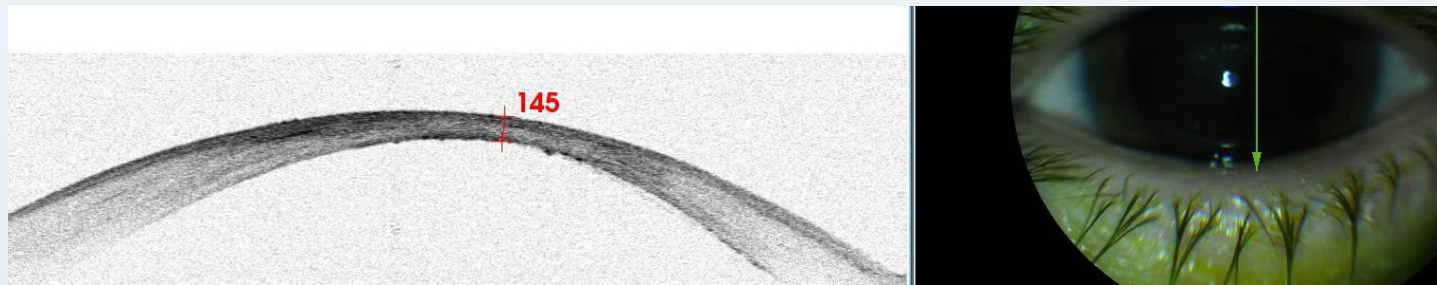
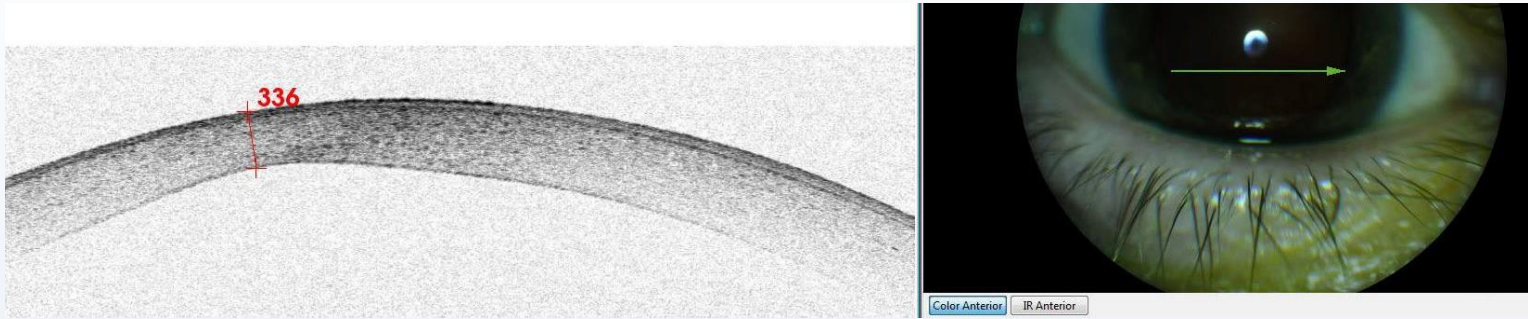
- Progressive disorder, almost always bilateral with one eye more advanced
- Increasing corneal thinning creates greater corneal protrusion, causing increasing changes in refractive error (usually higher myopia and astigmatism)
- Increasing irregular astigmatism causes a reduction in visual acuity

Stages of Keratoconus



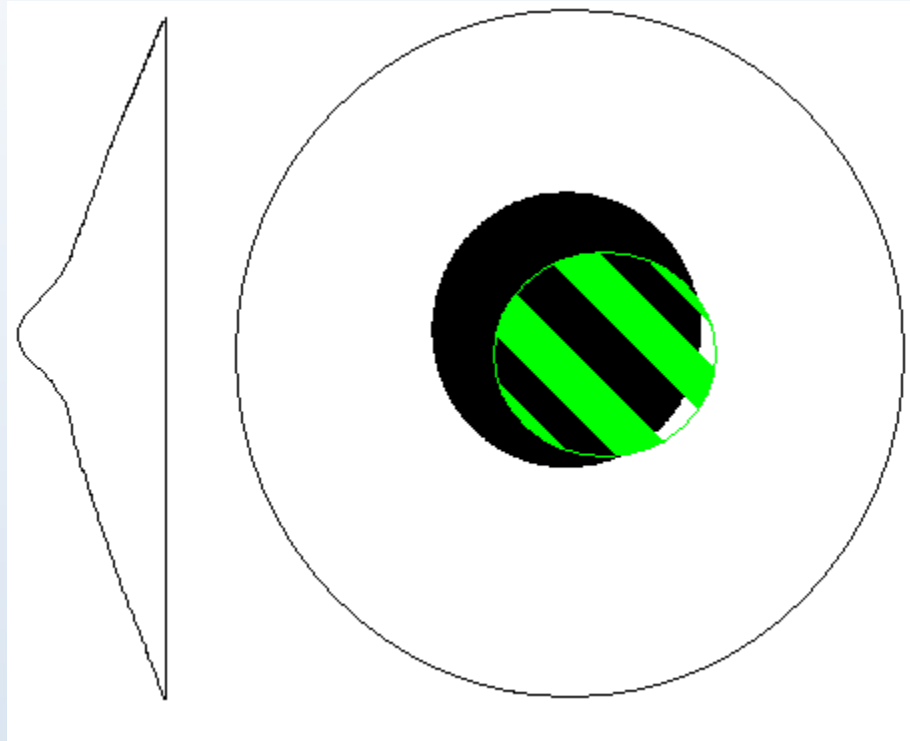
- Normal corneal thickness – 545um
- Mild keratoconus > 490um
- Moderate keratoconus > 400um
- Advanced keratoconus < 300um

Advanced Keratoconus



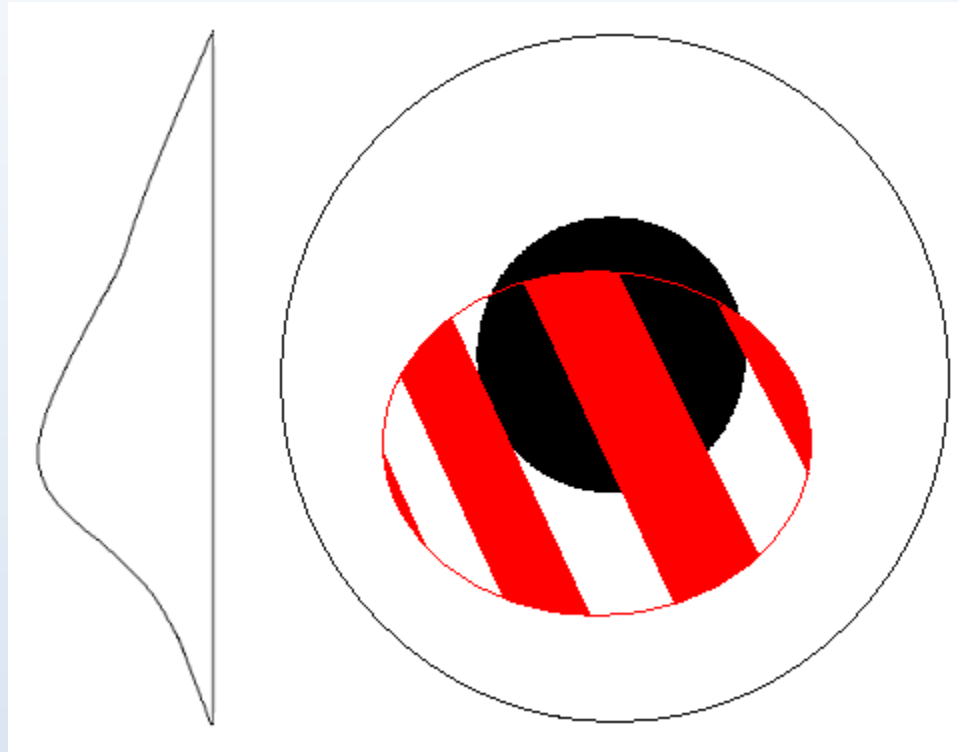
Types of Keratoconus

- **Nipple cone** - (~45%) – near the corneal centre or inferior nasal <5mm



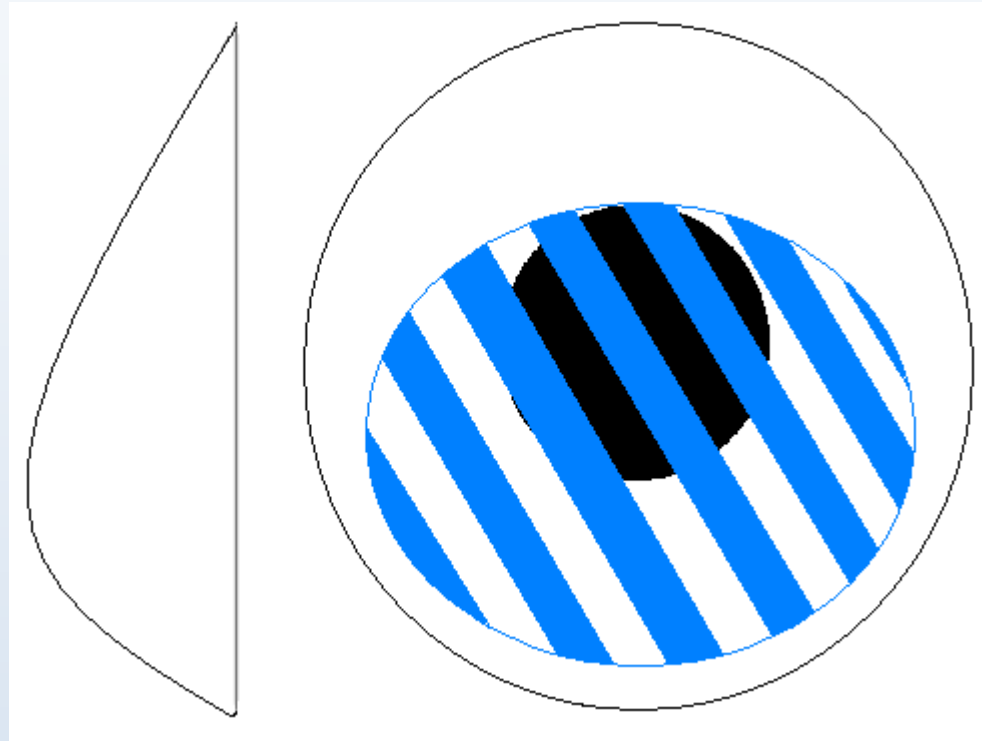
Types of Keratoconus

- **Sagging or oval cones** – (~50%) larger, below centre or inferior >5mm



Types of Keratoconus

- **Keratoglobus cones** – (5%) involving up 75% of the whole cornea



Causes of Keratoconus

- Multifactorial – Genetic, biochemical and physical
- Genetic predisposition, 8 – 10% have a family history
- Strong association with eye rubbing, trauma from contact lenses and allergic eye disease
- Stromal thinning possibly caused by increased activity of proteinase enzymes and decreased proteinase inhibitors causing reduced biomechanical stability

Epidemiology of Keratoconus

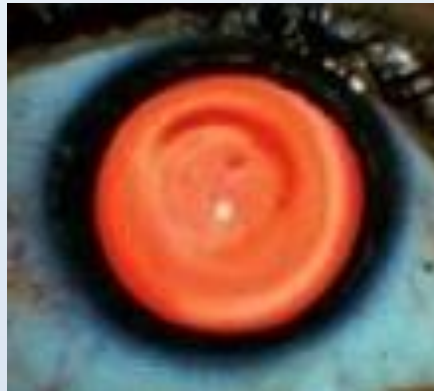
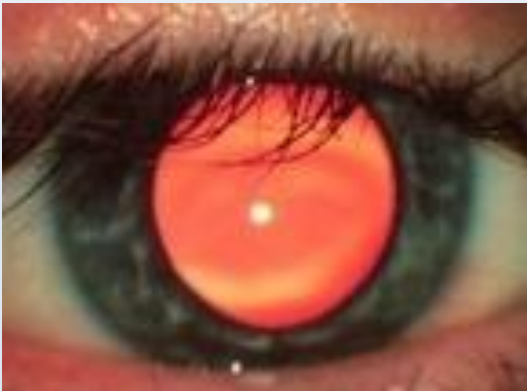
- Affects both genders and all ethnicities
- Prevalence (Caucasian) traditionally 54 per 100,000 (1 in 2000), recent studies have increased this to 265 per 100,000 (1 in 375)
- Increased prevalence most likely due to early detection and improvement in tomography (analysis of anterior and posterior corneal surfaces)
- More prevalent in South Asians and Pacific Islanders

Characteristics of Keratoconus

- Typically presents in adolescence
- Usually between 16 and 25 years, but can range from 8 to 45 years
- Earlier the age of onset, the more rapid the progression and the greater the severity
- Usually progresses until the 3rd or 4th decade
- **Progressive keratoconus can be treated by Corneal Cross-Linking (CXL) – for progression >1.0 D in 12 months**

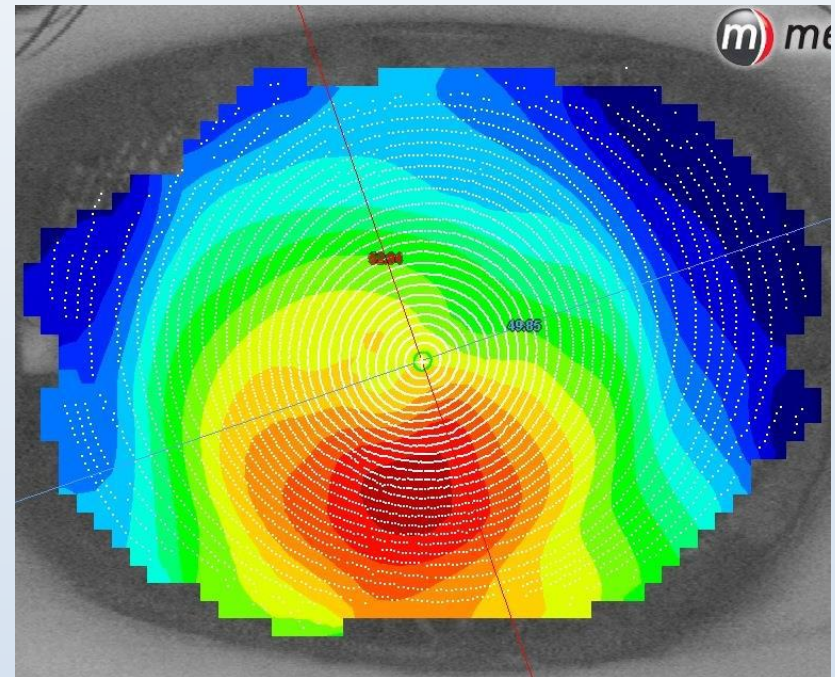
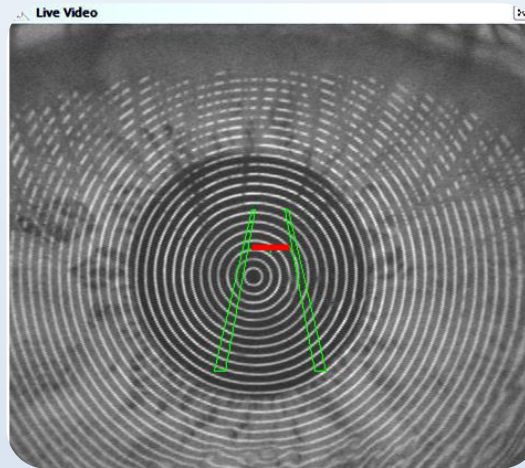
Signs of Keratoconus

- **Refractive error** - Refraction may show high myopia and either oblique or against the rule astigmatism. Frequent changes in refraction particularly the degree and amount of astigmatism.
- **Reduced visual acuity** – due to increasing distortion
- **Retinoscopy** – this will show an irregular scissors reflex, especially with a dilated pupil.



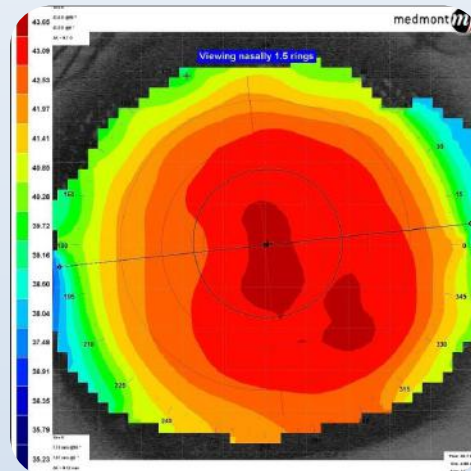
Signs of Keratoconus

- **Corneal topography** (Computer-assisted videokeratography)
 - Measures: 7,000-70,000 points across the cornea
 - Medmont **9,600** measurement points (standard deviation of error of 2 μm)
 - Corneal Area: 7.0-11.0mm
 - Medmont composite mapping up to 14 mm
extrapolated data out to 17 mm



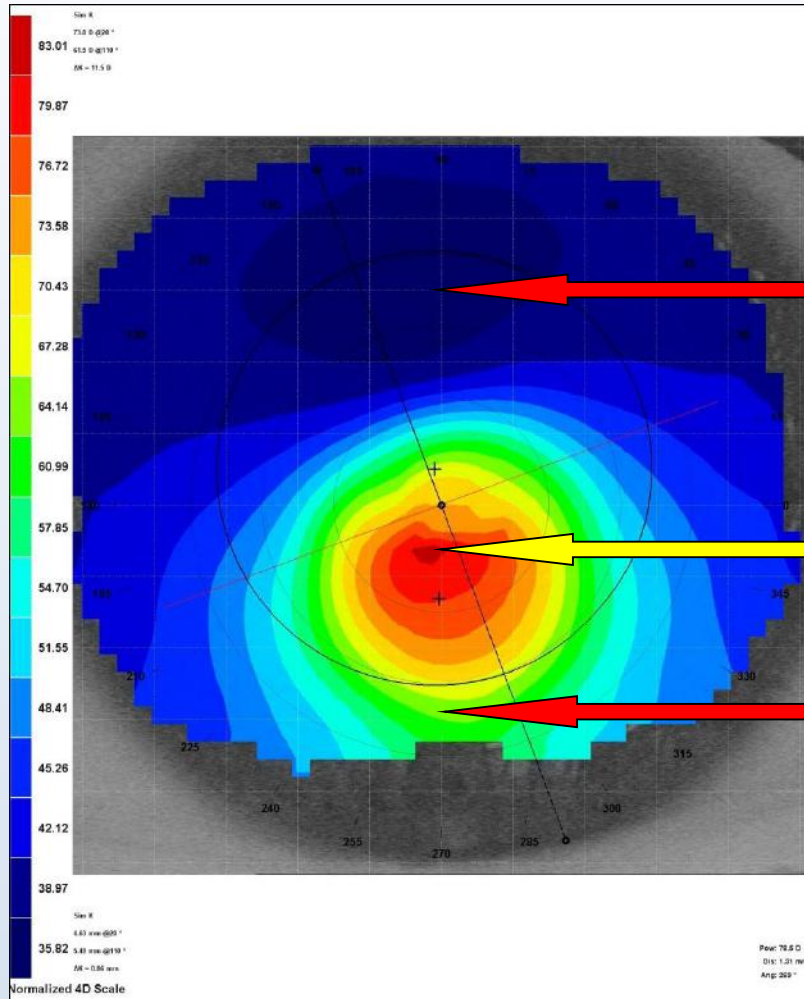
Signs of Keratoconus

- **Corneal topography**
 - Superior analysis of corneal shape
 - Axial, Tangential, Elevation, Refractive, Difference maps
 - Irregularity indices
 - Computer-assisted contact lens designs
 - Detection of corneal pathology/irregularity
 - Accurate monitoring of progression of corneal pathology



Signs of Keratoconus

Power change across the cornea



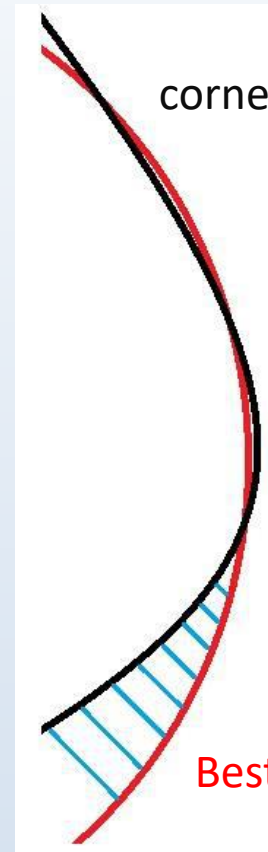
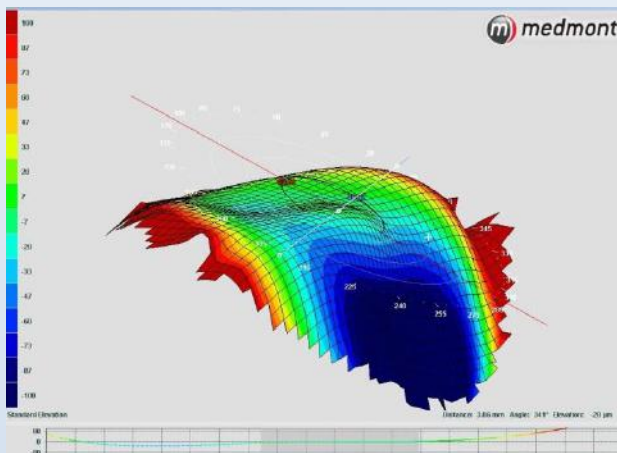
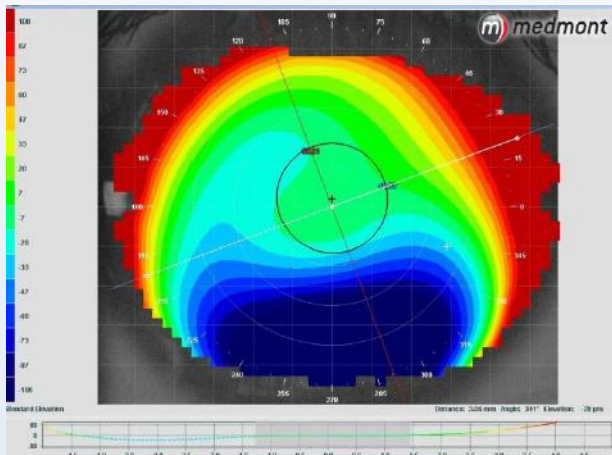
35D – 3mm above centre

83D – maximum curvature

61D – 3mm below centre

Signs of Keratoconus

- **Corneal topography** - Elevation map – height (μm) in front or behind a reference sphere or best fit sphere

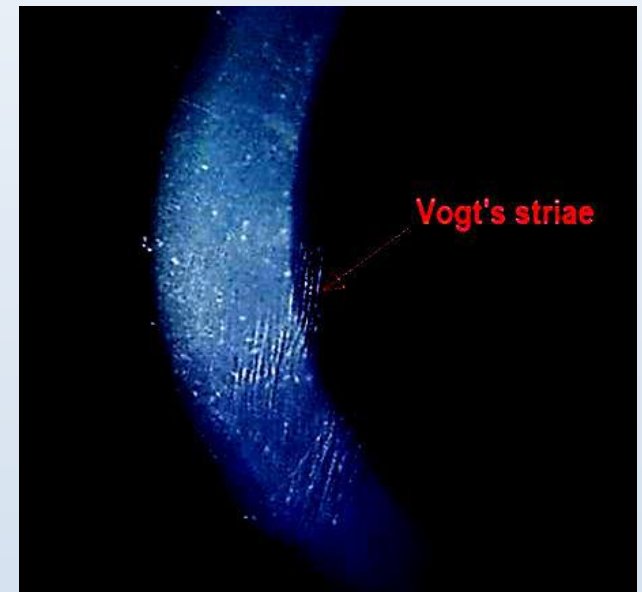


cornea

Best fit sphere

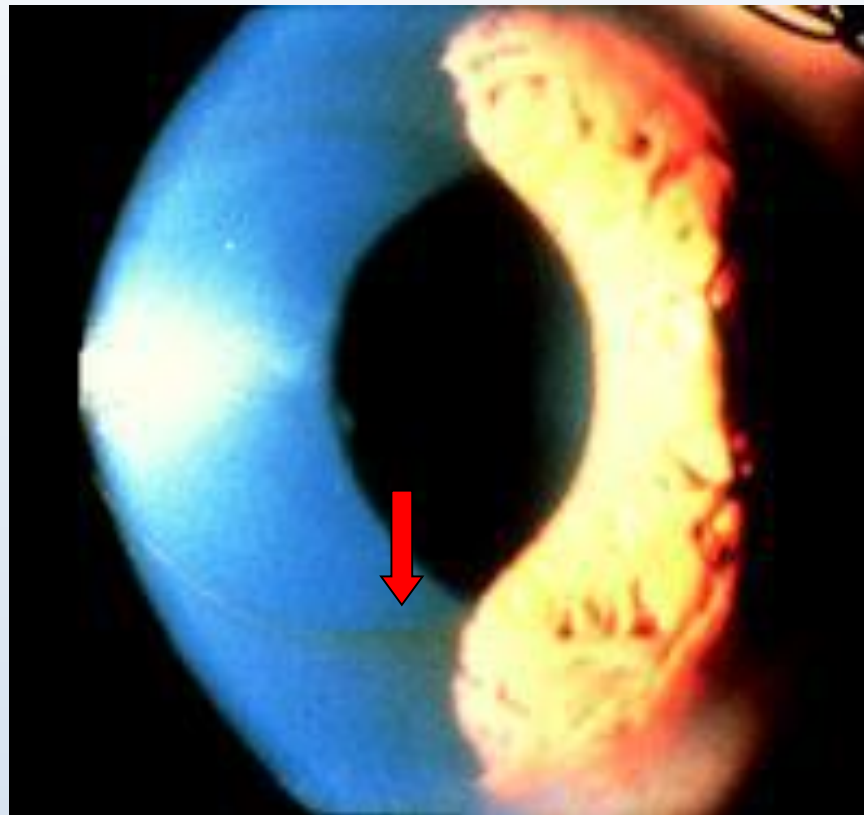
Signs of Keratoconus

- **Pachymetry** – ultrasound to monitor the corneal thickness.
- **Corneal nerves** – increased visibility (thicker fibre bundles), fine white lines, irregular angles
- **Striae** – (Vogt's striae) – very fine translucent, usually vertical lines in posterior stroma and Descemet's membrane, underlying the centre of the cone



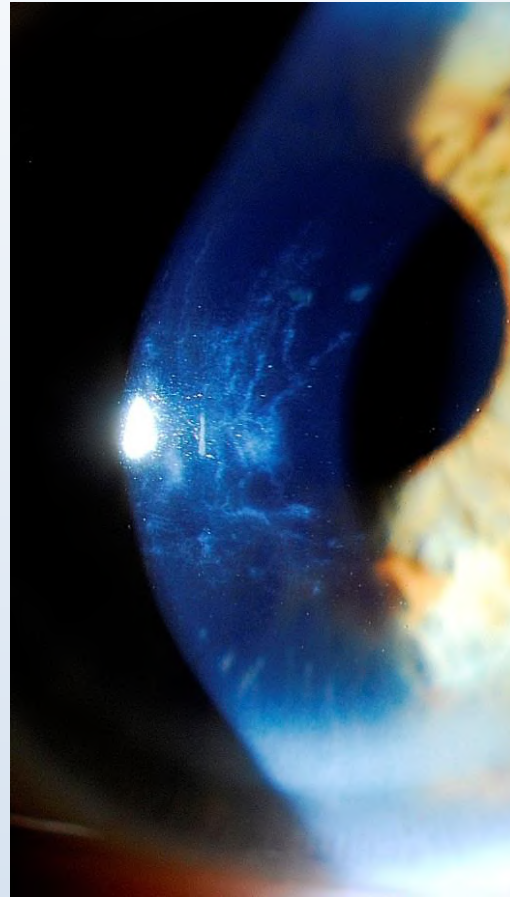
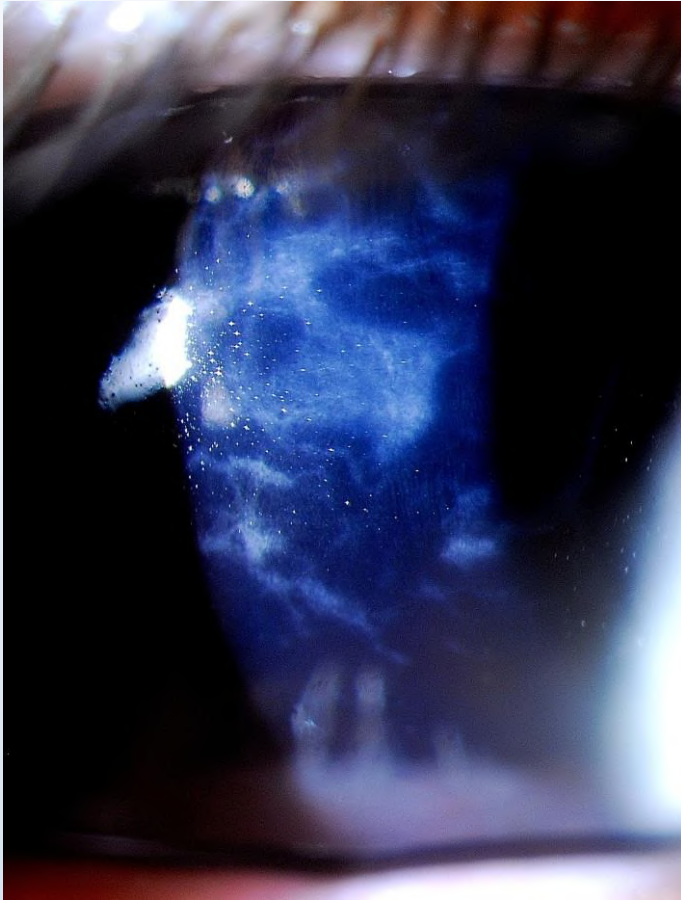
Signs of Keratoconus

- **Fleischer's ring** – brownish partial or complete iron deposition ring in deep epithelium at the base of the cone – increased visibility with blue light



Signs of Keratoconus

- **Corneal scarring** – anterior or posterior stromal scarring

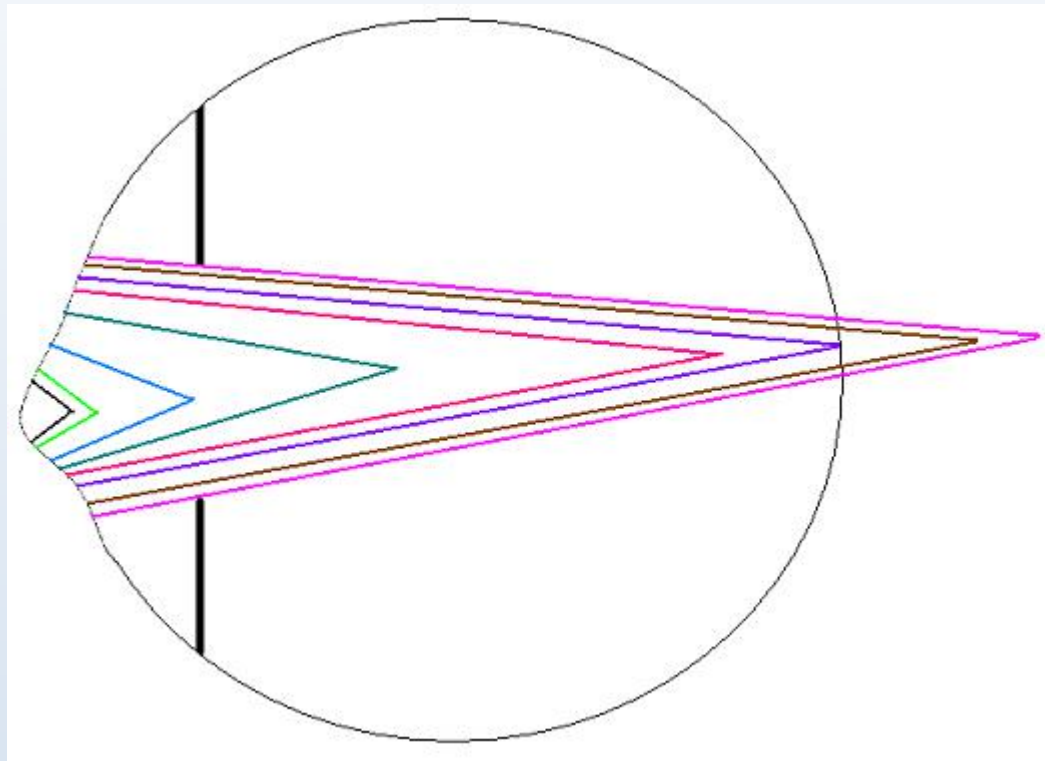


Symptoms of Keratoconus

- Greater difficulty with night vision, especially driving
- Eye strain, squinting and headaches
- Dry eyes, irritated eyes, itchy eyes, associated allergies
- **The Collaborative Longitudinal Evaluation of Keratoconus study (CLEK)**
 - 1209 subjects, 8 year, multicentre study
 - High contrast visual acuity underestimates the loss of acuity and function
 - **VA <6/12** or worse associated with reduced vision related quality of life

Symptoms of Keratoconus

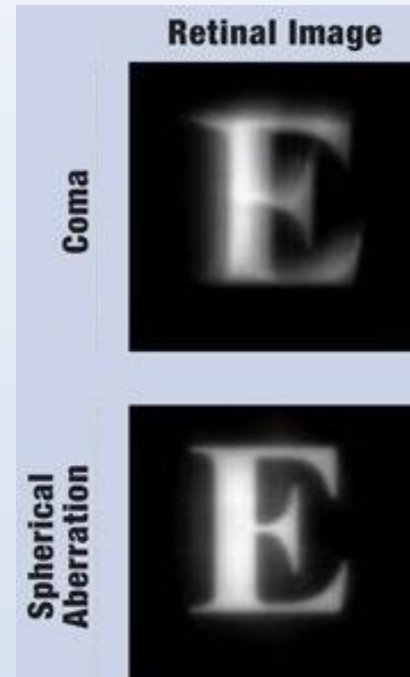
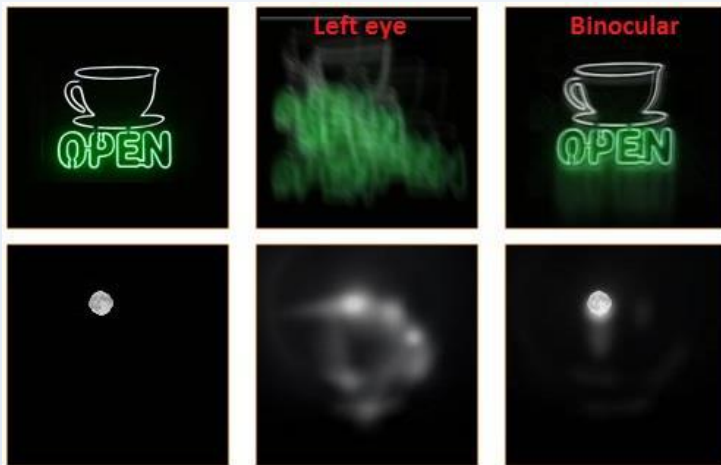
- Poor quality vision with spectacles - distorted vision, haloes, ghosting, flaring of lights



Symptoms of Keratoconus



- Increasing corneal asymmetry increases higher order aberrations – especially vertical coma
- The quality of vision will be different in each eye

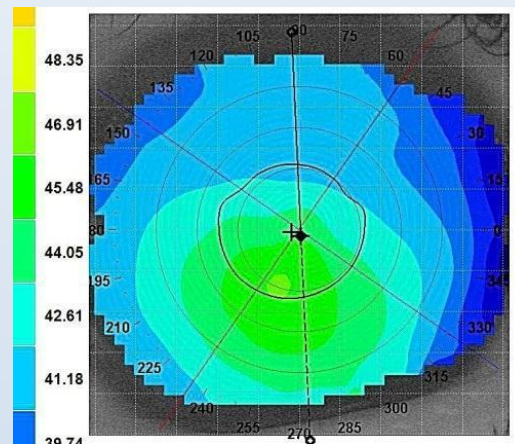


Stages of keratoconus

- **Forme Fruste keratoconus**

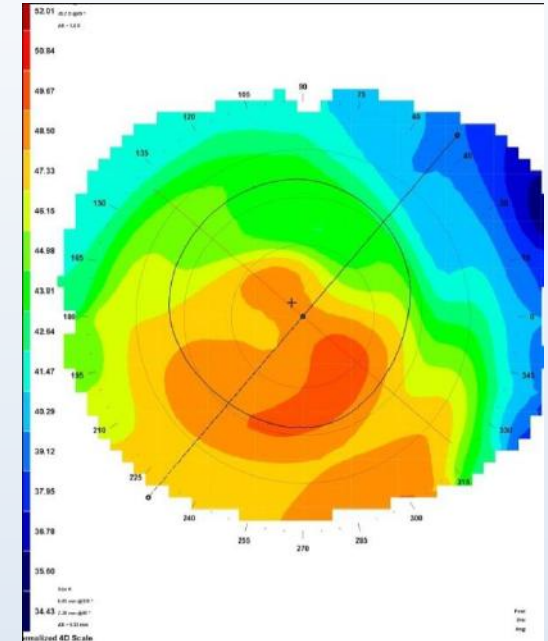
- Diagnosis confirmed by topography
- Very slight corneal distortion
- Little or no effect on the quality of vision, VA may be 6/6 – 6/4
- Slit lamp examination of corneal is normal
- **Minimal or no progression** over the years – monitored by topography and pachymetry
- Spectacles and soft contact lenses are successful in correcting myopia and astigmatism and give good acuity.
- No need for RGP lenses

Rx: R plano/-0.25x150 VA 6/5-
(-0.50 cyl change over 16years)



Stages of keratoconus

- **Early Keratoconus**
 - Diagnosis confirmed by topography
 - No significant symptoms
 - Minimal corneal distortion
 - Slit lamp - may appear normal
 - **Striae may be visible**
 - Fleischer's ring may be visible
 - No scarring or obvious corneal thinning.



Stages of keratoconus

- **Early Keratoconus**

- Spectacles give normal or near normal acuity – range of 6/5 to 6/8
- No significant awareness of distortion.
- Patients generally prefer spectacles, contact lenses are an option for cosmesis or sport
- Soft contact lenses – spherical or toric can be successful (disposable or long-term lenses)
- Patient may occasionally prefer an RGP contact lens for better acuity – e.g. for night driving

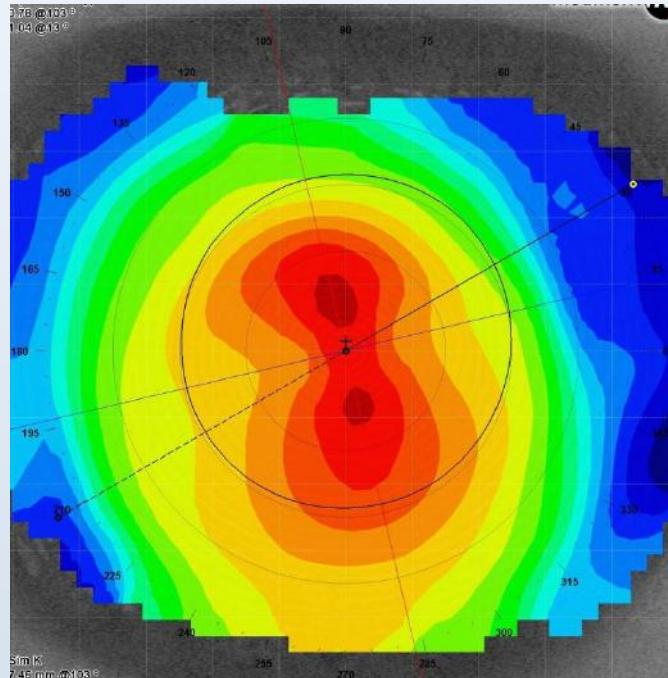
Stages of keratoconus

- **Moderate Keratoconus**

- Patient is aware of poor quality vision with spectacles or soft contact lenses – VA never as good as expected (6/7.5 – 6/12).
- More frequent spectacle changes (~ six monthly) with increasing myopia and astigmatism, also significant changes in cylinder axis.
- Slit lamp –
 - **Striae may be more obvious**
 - Fleischer's ring may be visible
 - subtle stromal scarring (anterior or posterior) may be visible.

Stages of keratoconus

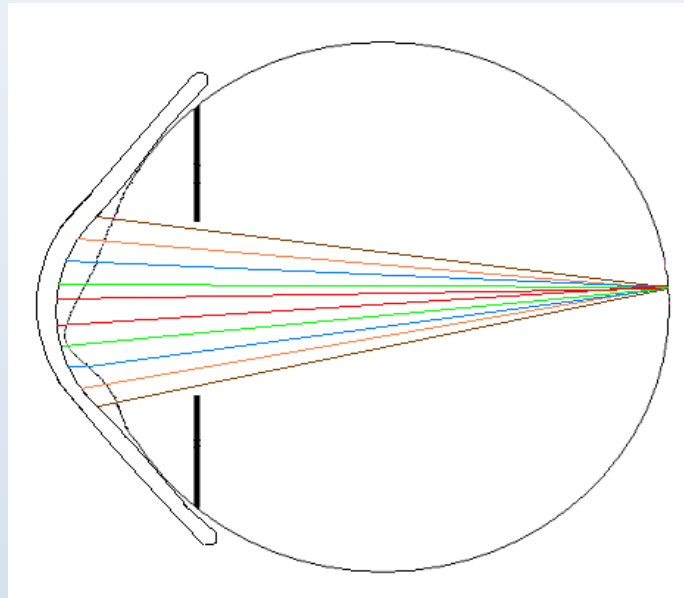
- **Moderate Keratoconus**
 - Increasing corneal distortion confirmed by topography
 - Increased awareness of ghosting, doubling of edges and flaring especially at night
 - Increasing difference of quality of vision between the eyes



Stages of keratoconus

- **Moderate Keratoconus**

- Increasing corneal distortion confirmed by topography
- Substantially reduced distortion and better acuity with RGP c/I,
- RGP lenses restore vision to normal or near normal levels
- (VA 6/6 - 6/9), RGP lenses reduce distortion by 90%.
- May have a slight residual distortion with RGP lenses, especially at night, dependent on pupil size

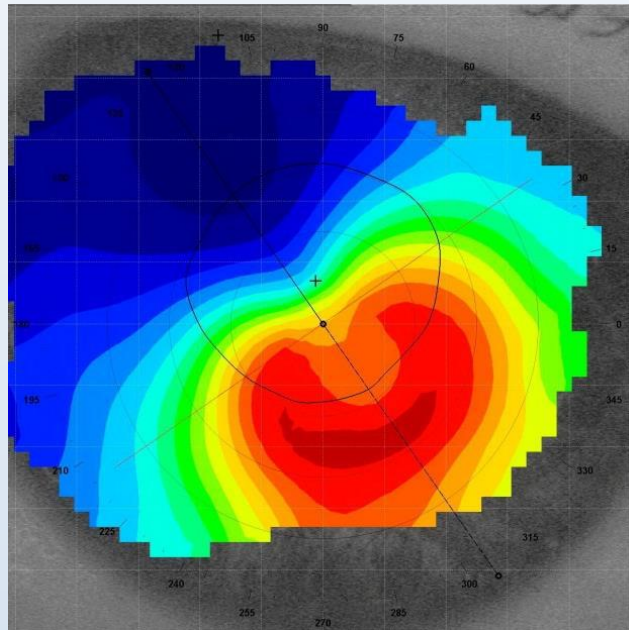


Stages of keratoconus

- **Moderate Keratoconus**
 - Emergency spectacles may still be useful, although acuity may not be 100%, patient may have significant myopia and astigmatism
 - E.g.: Unaided vision 6/120
 - Refraction: -6.00/-3.50x137 VA: 6/15-2

Stages of keratoconus

- **Severe Keratoconus**
 - May have slight to moderately reduced VA with RGP lenses (in the range of 6/7.5 to 6/12)
 - Substantial corneal steepening confirmed by topography



Stages of keratoconus

- **Severe Keratoconus**
 - Slit lamp
 - Moderate striae
 - Fleischer's ring may be visible
 - Often moderate stromal scarring
 - Corneal thinning visible
 - Increased corneal curvature obvious with thin slit
 - RGP lenses need very steep curvatures to clear the cone, < 6.2mm BCOR
 - May develop reduced tolerance to RGP lenses with reduced wearing times, even with a good fitting RGP c/l.
 - May need special lenses – soft carrier lenses – underneath the RGP c/l, SynergEyes lenses (Hybrid design) or miniscleral designs to maintain reasonable wearing schedules.

Stages of keratoconus

- **Severe Keratoconus**
 - As the corneal distortion increases it may be very difficult to achieve an acceptable contact lens fitting
 - Contact lenses may be unstable or uncomfortable
 - Once the visual acuities with contact lenses, drop below **6/12 to 6/18**, the quality of vision is not adequate for most general vision tasks – driving, lectures, computer, reading.
 - Patient is then referred for a corneal transplant or corneal graft.
 - **Only 10 – 15% of patients with keratoconus need to have a corneal transplant**

A successful contact lens gives good vision, is stable and comfortable, and can be regularly worn for all of the day and doesn't make the eye red.

- Contact lens options for keratoconus



- Soft lenses
- Rigid Gas Permeable OD: 8.0 – 10.0 mm
- Intra Limbal: 10.1 – 12.0 mm
- Corneo scleral: 12.5 – 13.5 mm
- Silicon Hydrogel carrier lenses under RGP – “piggyback”
- Hybrid (RGP centre, Soft skirt): 14.5 mm
- Miniscleral: 15.0 – 18.0 mm
- Scleral: 18.0 – 23.0 mm

Contact lens assessment

- **History**
 - Work environment – dust, air-conditioning
 - Allergies
 - Dry eye
 - Sport – darts vs triathlon
- **Slit lamp examination**
 - Corneal abnormalities – baseline measurements
 - Corneal scarring
 - Corneal staining
 - Quality of the tear film
 - Upper palpaebal conjunctiva – papillae

Contact lens options

- **Forme Fruste and early Keratoconus**

If spectacles give good VA - soft contact lenses (spheres and torics), will give good vision with good comfort.

Soft Contact Lenses

- Standard long-term custom soft lenses
- Thick custom soft lenses can mask slight corneal irregularity
Soft-K (USA), H₂O: 67% DK: 28, centre thickness: 0.38mm
(ct – Silicon Hydrogel lens Bausch&Lomb - PureVision 0.09mm)
- Thick Hydrogel materials (low oxygen permeability) hypoxia may lead to blood vessel ingrowth into the cornea.

Contact lens options

- **Forme Fruste and early Keratoconus**

- Disposable Silicone Hydrogel lenses**

- May mask more corneal irregularity (increased stiffness) and give acceptable vision as well as high oxygen permeability.

- **Spherical:** daily to monthly replacement

- **Toric:** daily to monthly replacement

- Custom lenses**

- **HEMA, 45G** – spherical and toric

- **Silicone Hydrogel** – Spherical and toric

- Capricornia – Definitive

Contact lens options

- **Moderate and severe Keratoconus**

If unable to obtain good visual acuity with soft lenses, RGP lenses are required

- Spherical RGP lenses - either tri-curve or quad-curve periphery

Capricornia, Gelflex, Contact Lens Centre (CLC),
Innovative Contact Lenses

- Aspheric lenses

Gelflex – Limbal Lift, Capricornia – KBA, Gelflex – Keracon, K1, K2, Korb,
CLC – Centra PGA, Rose K

- Hybrid lenses (RGP centre, soft periphery) SynergEyes – KC, ClearKone, UltraHealth

- Miniscleral lenses

Capricornia – Katt or ICD, Innovative Contact Lenses – 5zRS, Gelflex

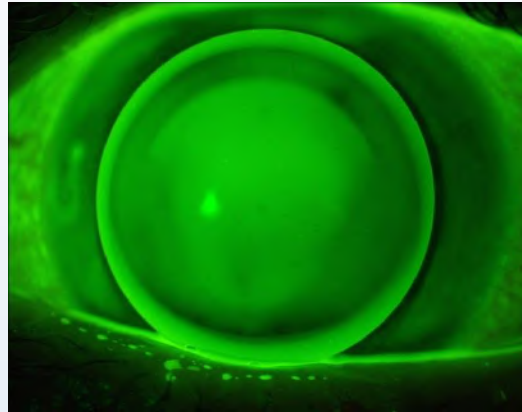
RGP contact lenses for keratoconus

- **RGP fitting** – fluorescein pattern

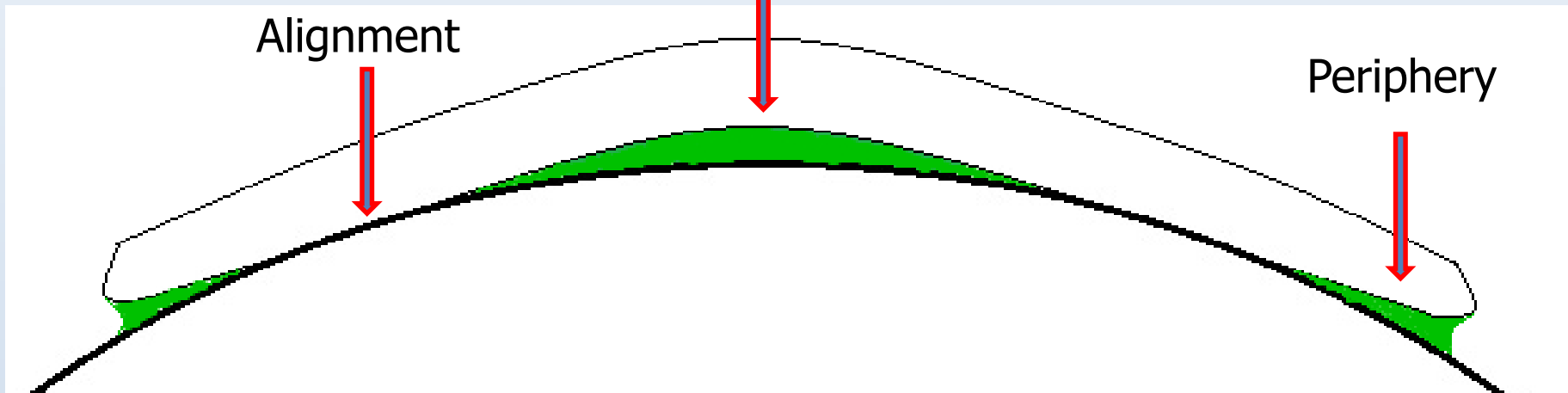


RGP contact lenses for keratoconus

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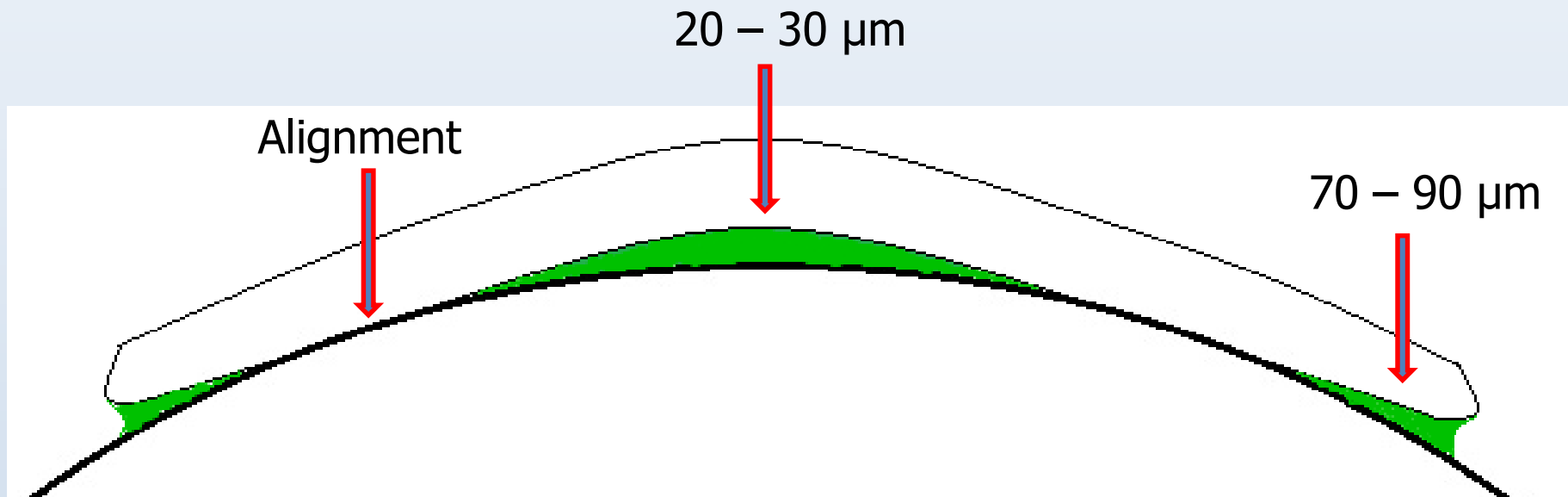
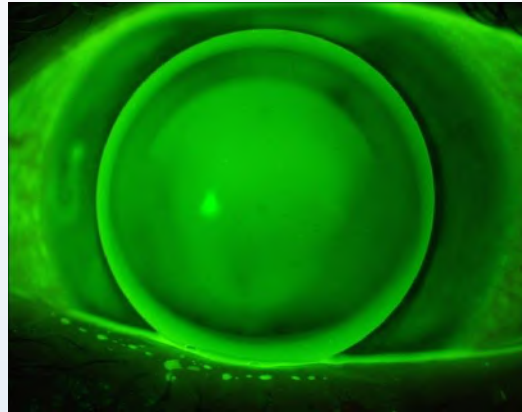


Central



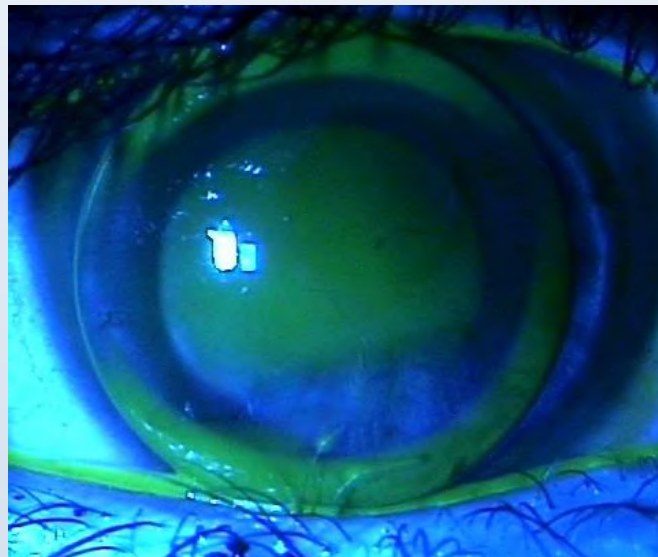
RGP contact lenses for keratoconus

- **RGP fitting** – fluorescein pattern



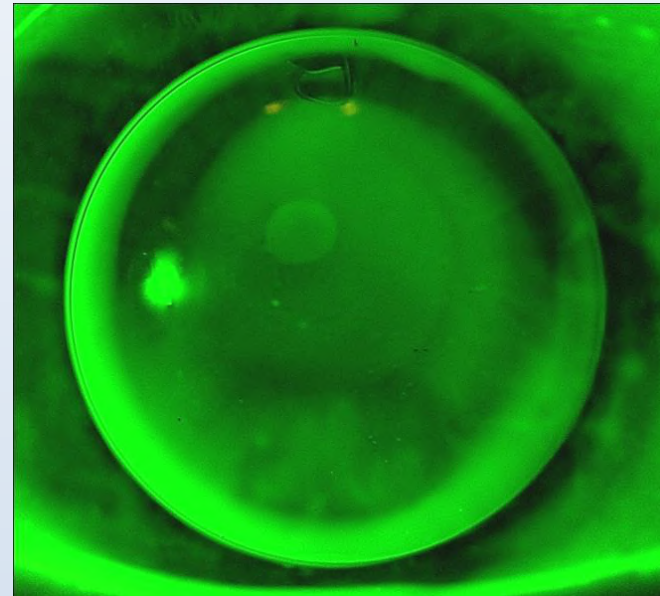
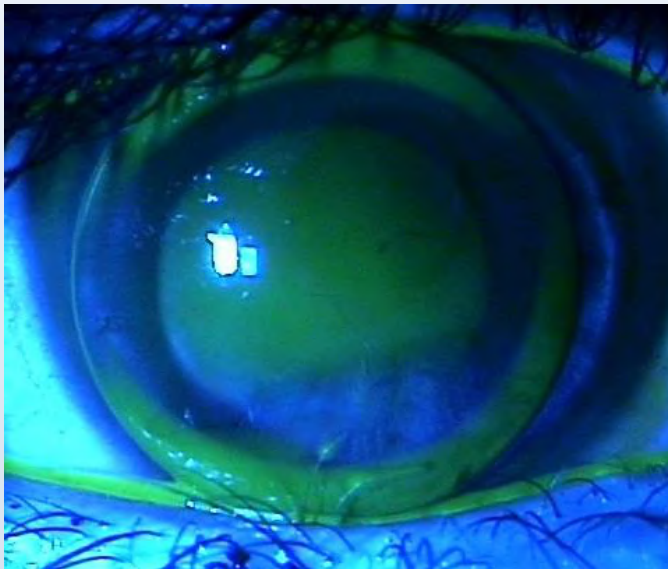
Fluorescein Patterns

- Fluorescein was first used for corneal investigations in 1888
- Blue filter observation was first introduced in 1938, almost 100% of the absorbed light is converted to fluorescent light.
- The intensity of fluorescence varies with thickness of the tears – thicker areas of tears are bright green and thin areas are dark green, areas with no fluorescein are black.



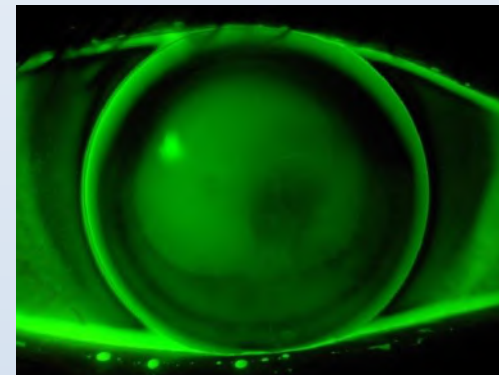
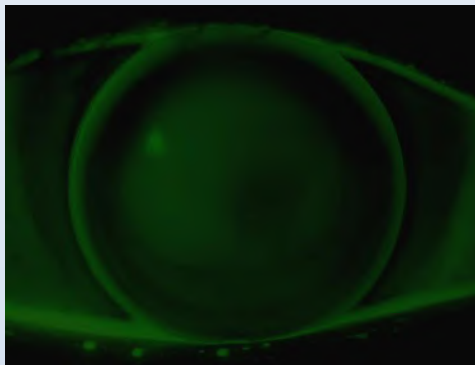
Fluorescein Patterns

- The cornea produces natural fluorescence, with a blue light. This can be filtered out with a yellow barrier filter – (Wratten filter)
- Wratten filter increases contrast, much easier to detect subtle changes in fluorescein patterns and faint corneal staining



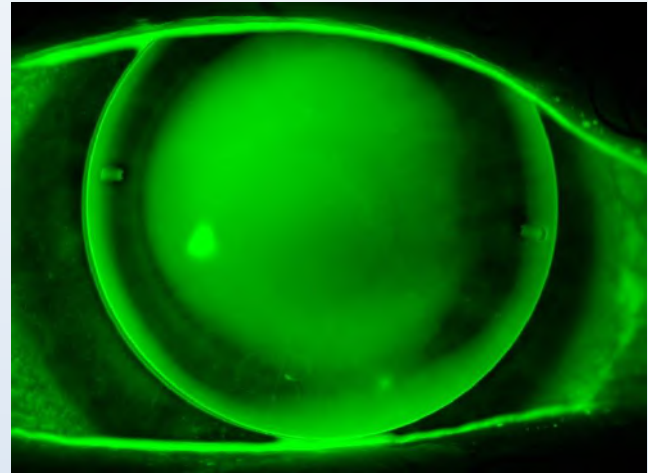
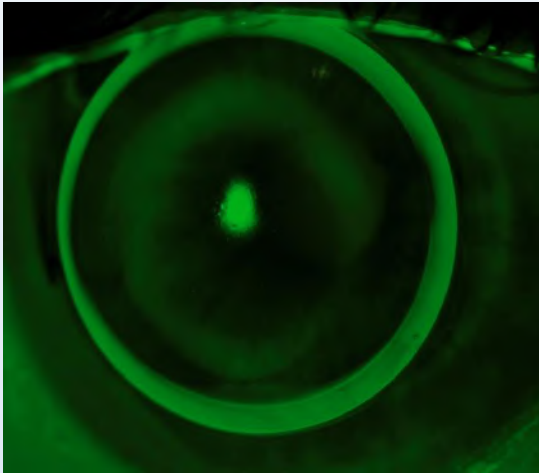
Fluorescein Patterns

- pH affects the fluorescence of fluorescein – pH < 6.0 has half of the fluorescence of pH 7.0.
- Need to use buffered saline for maximum fluorescence.
- Need to try and insert a repeatable amount of fluorescein
- **The minimum tear layer thickness for the tear film to fluoresce is 20 μ .**
- The amount of fluorescence will depend on the concentration of fluorescein
- Excessive fluorescein results in quenching of the fluorescence effect
- Fluorescence can be restored by diluting 1-2 drops of this with saline



Fluorescein Patterns

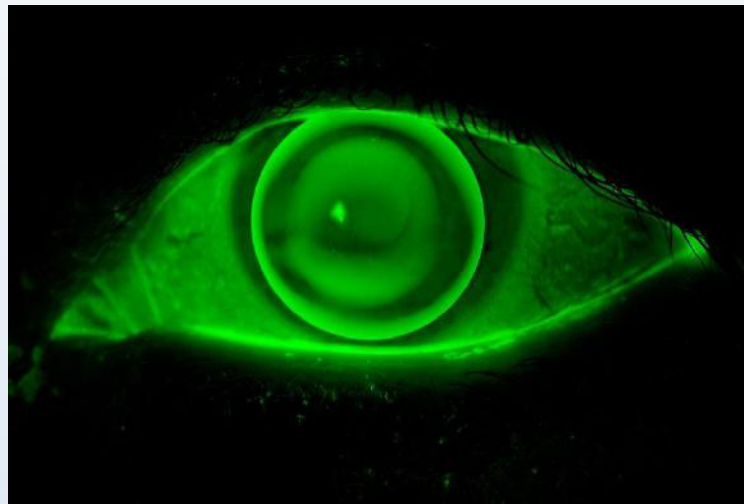
- Need adequate fluorescein
 - Too little solution (<20 μ m tear layer thickness will appear as bearing)
 - Excessive solution – lens will appear steep



- Use anaesthetic – reduces reflex tearing, improved patient comfort and allows for easier assessment of the fluorescein pattern

Fluorescein Patterns

- Observe the fluorescein pattern with the naked eye and blue light
- Use low slit lamp magnification (6 – 10x), high illumination and a wide beam



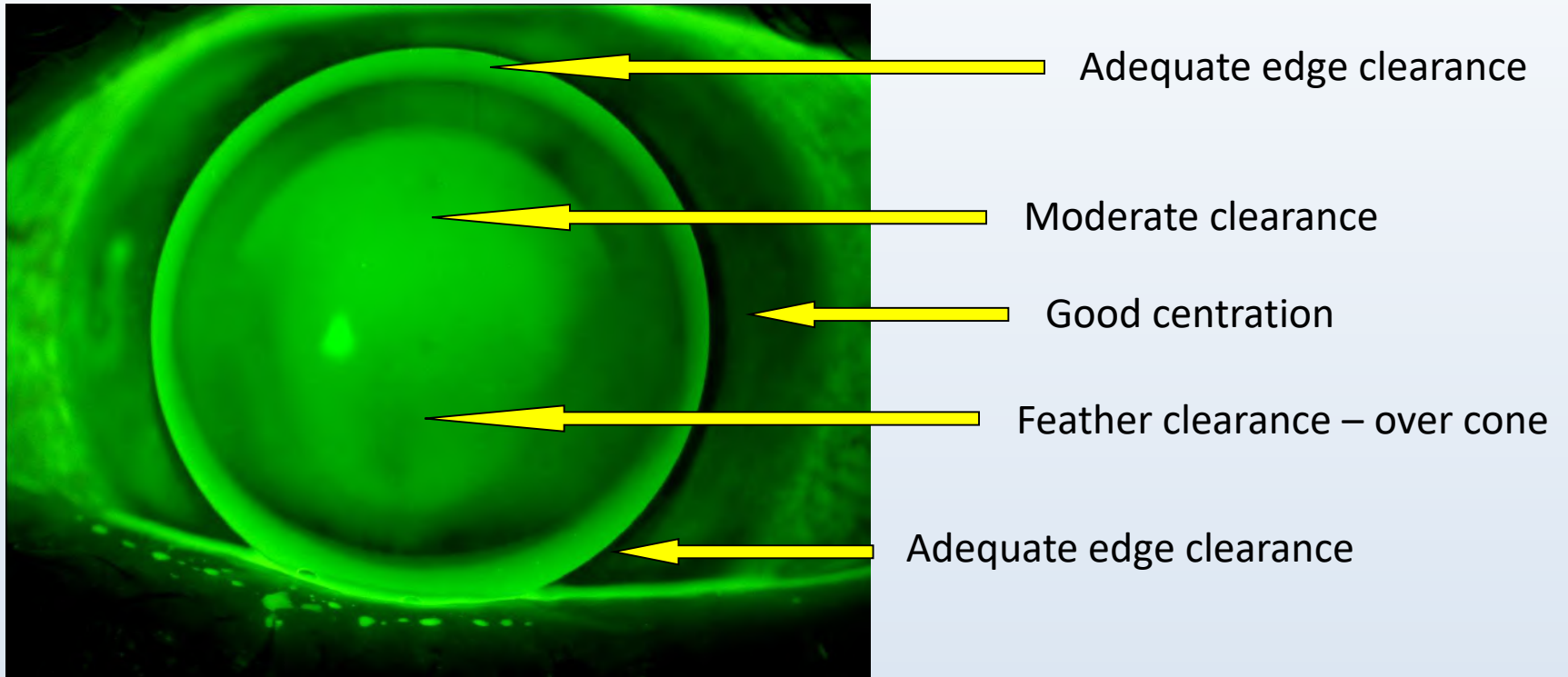
- The amount of fluorescein required can vary from patient to patient and depends on tear viscosity and reflex tearing
- Observe after 1 minute, Review after 5 minutes

Fluorescein Patterns

- Keep reviewing the fluorescein pattern, as the lens settles the pattern can appear to change.
- A lens that initially looked steep may later appear as slightly flat and the reverse.
- Once you have a lens that looks close to a good fit, keep it on the eye for 10-15 minutes and keep reviewing the fitting. You can complete an accurate over refraction during this period.

RGP contact lenses for keratoconus

- **RGP fitting** – fluorescein pattern



Keratoconus - 1

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