



For many practitioners orthokeratology still remains a mystery and is considered to be a specialist contact lens procedure. The aim of this article is to provide practitioners with an understanding of the process and ultimately the ability to implement orthokeratology into everyday practice.

We will cover the following areas:

- A background and the theory behind orthokeratology
- Preparing yourself and your practice
- Patient selection
- Lens selection
- Follow-up and problem-solving.

It has to be stressed that this is purely an introduction. Any practitioner wishing to start fitting orthokeratology would be well advised to attend manufacturers' workshops, read up on the topic, experiment with topographers and speak to fellow practitioners for more detailed advice. Next year *Optician* will be publishing some follow-up articles for those wanting to develop their orthokeratology skills further.

### What is orthokeratology?

Since the advent of rigid contact lenses, corneal reshaping has always been an unwanted and uncontrollable by-product of wearing rigid lenses and was commonly referred to as 'spectacle blur'. At the 1962 International Society of Contact Lens Specialists conference in Chicago, George Jessen described how he fitted lenses flatter than the flattest keratometry reading (Kf) to achieve a temporary reduction in myopia on lens removal. At the same conference Newton Wesley named the process as 'orthokeratology'. In 1976, Kerns defined orthokeratology as 'the reduction, modification or elimination of refractive error by the programmed application of contact lenses'.

At this juncture orthokeratology had a limited appeal because the procedure was unpredictable and was only suitable for low myopes – generally less than 2D of refractive error. The flat fitting nature of the lenses also meant that they would easily decentre, leading to a displaced treatment zone and ultimately visual distortion. Patients would also have to undergo several lens fittings with the lenses being made progressively flatter with each refit. Successful patients would then wear lenses during the day and remove them to get clear vision for a few hours in the evening. All in all patients would have to pay for several lens fittings to achieve a few hours of

# Beginner's guide to orthokeratology

Shelly Bansal offers some valuable information for those thinking of branching into corneal reshaping with contact lenses. Module C19930, one CL point for CLOs, one general point for optometrists and CLOs

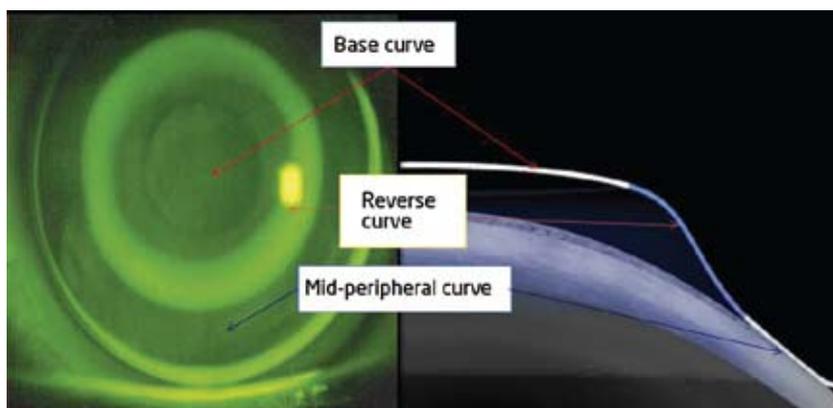


Figure 1 The reverse curve in situ and in cross-section

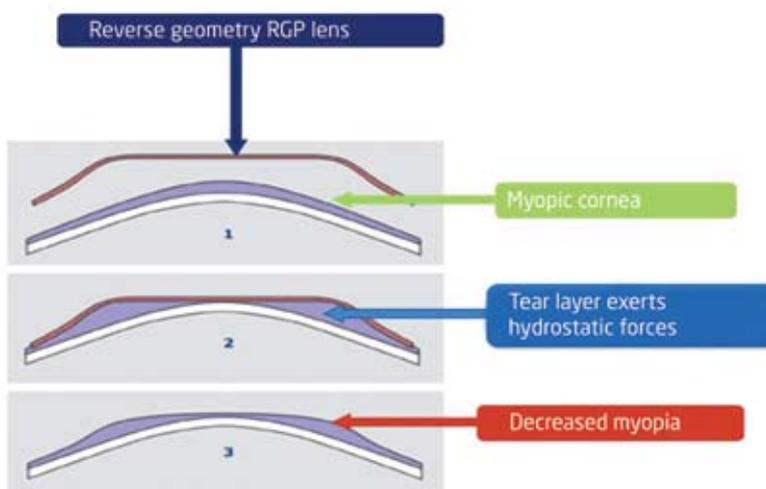


Figure 2 Reverse geometry RGP lens applied to a cornea, leading to epithelial redistribution

correction-free vision. Consequently, the only patients who benefited were those who needed to achieve specific standards of vision for their work or sports.

The advent of computer numerical controlled (CNC) high precision lathes, reverse geometry contact lens designs, corneal topographers and super high Dk rigid gas-permeable lenses has totally revolutionised and revitalised this area of contact lens practice.

Today, with accelerated orthokeratology, high Dk reverse geometry RGP lenses are worn overnight and then removed on awakening, giving the patient uninterrupted and clear vision

throughout all waking hours. The basic principles are the same, in that a flatter than Kf base curve is used to flatten the corneal shape and correct the myopia. A current spectacle prescription and accurate measurements for corneal shape and diameter, which have been taken with a corneal topographer, are used to determine the necessary base curve. A simplistic view of this is that if you know the exact shape of the cornea and the exact spectacle correction required, you can calculate exactly how much flatter the cornea needs to be to give perfect unaided vision. This, after all, is exactly what happens with corrective surgery. The reverse curve of the contact lens links



the mid-peripheral curve to the base curve of the lens and also provides an area of redistribution for the cells from the central corneal epithelium. The reverse curve also allows the mid-peripheral curve to be aligned to the corneal surface. The mid-peripheral curve is similar to that of a traditional RGP lens and enables better centration and therefore gives a better end result. Finally, the edge curve – as with standard RGP lenses – assists tear exchange and ease of removal. Figure 1 shows this both in diagrammatic form and also *in situ*.

Figure 2 shows a reverse geometry RGP lens being applied to a myopic cornea. The lens is then worn overnight. The shear forces applied by the lens on the tear film make the cells of the cornea move from the centre to the mid-periphery. On lens removal the central corneal epithelium is now flatter – giving full refractive correction – and the mid-periphery is steeper – making it more myopic.

## Practice essentials

Successful orthokeratology contact lens fitting relies on the same fundamentals as all other forms of contact lens practice, namely an accurate and up-to-date refraction and full history and symptoms. Corneal topography is essential as it is used to order the initial lenses and it is only through comparing topography maps that practitioners can understand if the procedure is working or what modifications may be required.

Again, patient selection is an essential factor in maximising success in practice. The procedure is ideally suited for low to moderate myopes ranging from -1.00DS to -4.50DS with no more than -1.25DC of with-the-rule corneal astigmatism. Patients with more than -0.75DC of against-the-rule corneal astigmatism are not suitable candidates. Caution should also be applied to patients with lenticular astigmatism, as the re-shaping process has no effect on this. With higher degrees of astigmatism the lens is more likely to be displaced and therefore produce a decentred treatment zone, resulting in a reduction in visual performance. Astigmatic and high myopia designs are currently available, but it is the author's recommendation that any practitioner who is new to orthokeratology should gain confidence by fitting the relatively easier patients first. Ideal candidates can be of any age and with and without previous contact lens wear. Again caution has to be applied with existing RGP lens wearers, as they would

**TABLE 1**

**Some of the more widely used lens suppliers**

Lab	No 7	Scotlens	DLT Menicon	Northern Lenses	i-Go Optical
Product name	EyeDream	Nocturnal	MeniconZ Night	Z Wave	i-Go
Workshops	Yes	Yes	No	No	No
Accreditation	Yes	Yes	Yes	No	Yes
Fitting software	Yes - all	Yes - all	Yes - all	Some topographers	Some topographers
Online ordering	Yes	Yes	No	Yes	Email
Online support	Yes	Yes	No	Email	Email
Tele-support	Yes	Yes	Yes	Yes	Yes
Marketing	Yes - extensive	Yes	Yes	Yes	Extensive

benefit from a full washout period from their current lenses (4-6 weeks) to ensure good baseline refraction and topography readings. It goes without saying that patients with systemic diseases affecting the eyes, ocular pathology, and irregular sleep patterns or post-refractive surgery patients are not good candidates.

Orthokeratology is ideal for patients with low grade dry eyes, as no lenses will be used during waking hours. For the same reasons orthokeratology is also a perfect recommendation for patients who are actively involved in sports or those who might be contemplating corrective surgery. The big advantage of orthokeratology is that it is a totally reversible procedure and leaves the door open for patients when new advances are made available. It has also been shown that orthokeratology lenses may slow down the development of myopia. A consequence of flattening the central cornea is that the peripheral cornea becomes steeper and therefore more myopia giving peripheral defocus for distance vision. It is thought that this defocused peripheral image shell falls short of the peripheral retina and this stops the peripheral retina from

elongating and therefore stabilises myopia.

Having selected the right patient and taken all the correct measurements you are now ready to order lenses for your patient. Table 1 lists some of the more widely used lens suppliers and some of their key benefits. Most suppliers will need spectacle Rx, K readings, HVID and pupil diameter (normal light) measurements as a minimum, in order to supply you with lenses.

On receipt of the lenses it is important to ensure that they have been correctly calculated. Checking the lenses *in situ* will verify that they are suitable. The lenses should be well centred in all directions of gaze. There should be no more than 1mm to 1.5mm movement. Fluorescein patterns should show a central area of touch, about 4mm in diameter, which is evenly surrounded by an annulus of tear reservoir corresponding to the reverse curve. The peripheral curve should be 1.5mm wide and with corneal alignment. Finally, there should be an even edge band all around the lens (Figure 3). The patient's best-corrected visual acuity should be achieved with lenses *in situ* and there may be a residual positive over-refraction. Assuming that this is all in order, the patient should be coached in lens application and removal. Traditional RGP care systems can be used for lens maintenance, although peroxide systems with neutralising tablets are also highly efficient.

## Follow-up

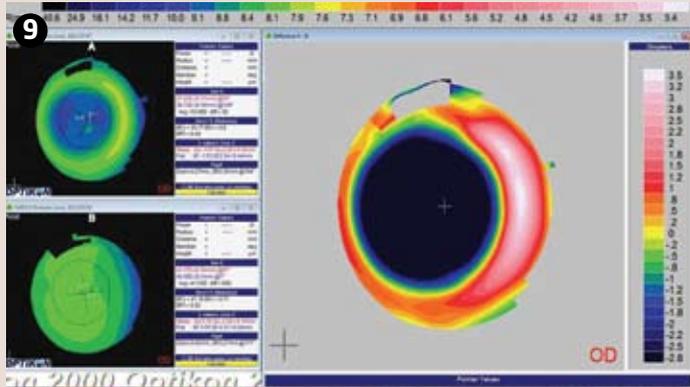
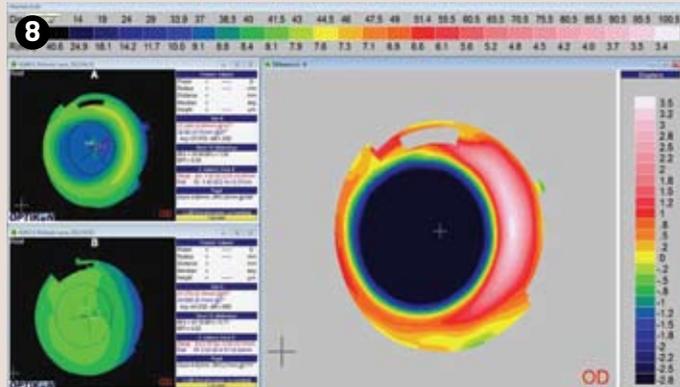
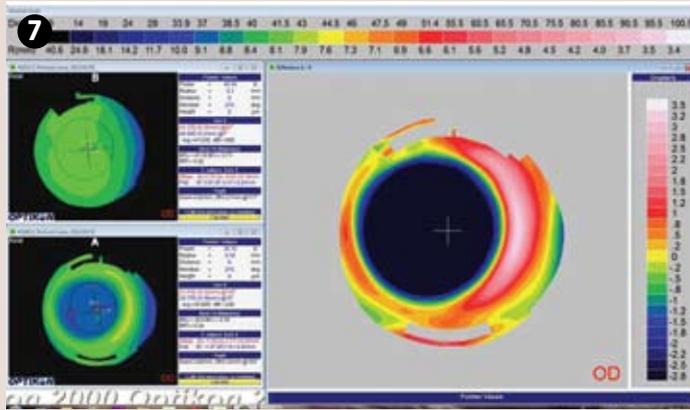
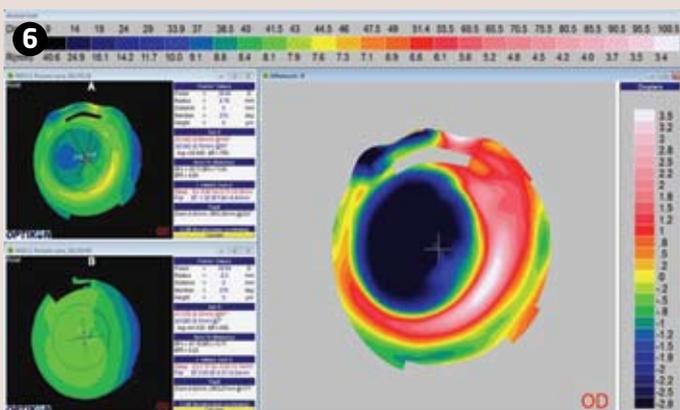
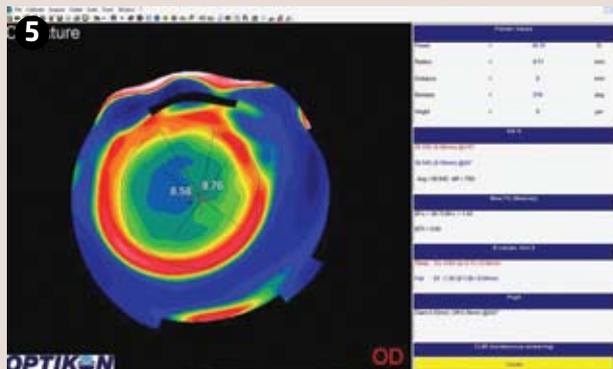
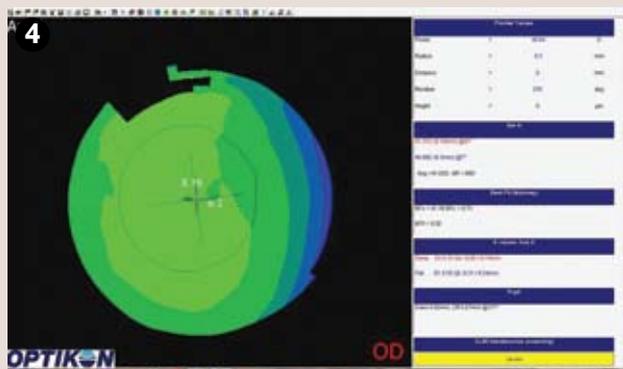
The first follow-up appointment should be immediately after the first night of lens wear and as early as possible in the morning. The patient should present



**Figure 3** There should be an even edge band around the lens



# CET Contact Lens Monthly



## CASE STUDY (RE ONLY)

An 11-year-old patient is new to contact lenses (03-03-2012). His mother is very myopic and is concerned her son is following in her footsteps. LR has healthy eyes and there is no contraindication to orthokeratology.

RX RE - 4.00/ -0.25 x 70 6/6. Figures 4-9 show the corneal reshaping as the orthokeratology proceeds:

**Figure 4** (03-03-2012) Baseline topography

**Figure 5** Topography after one night of wear. Central flattening achieved with mid-peripheral steepening

**Figure 6** (24-03-2012) Difference map after first night of lens wear shows that central flattening achieved. V 6/9 -0.75 6.6+

**Figure 7** (31-03-12) Difference maps show that the treatment zone has become more central and larger. V 6/4.8 +0.75 6/4.8

**Figure 8** (21-04-12) Difference topography map shows consistency with last reading. V 6/6++ +0.25 6/6++

**Figure 9** (07-07-12) Difference map still shows consistency. V 6/6++ +0.50 6/6++

In this case study, no changes were made to the lens parameters, and 4.5D of corneal flattening was achieved

wearing the contact lenses. Again the lens fitting should be verified and an over-refraction conducted with the lenses *in situ*. Special attention should be paid to any signs of excessive lens binding. A full slit-lamp examination should be conducted after lens removal. It is quite common to see signs of dimple veil in and around the

steep reverse curve zone of the lens. Topography maps should then be taken and the difference from baseline noted. Irregular and decentred treatment zones are not uncommon at this stage of the treatment and practitioners should avoid making changes to the lenses – unless there is an obvious reason to do so. In most cases the patient can expect

at least a 70 per cent reduction in their refractive error after the first night of lens wear. Assuming that everything is satisfactory, the patient should be seen again within a week, and should present having taken the lenses out. For higher prescriptions the patient could be issued with a variety of daily disposable lenses to improve vision in



the short term. Again, a full slit-lamp examination and corneal topography should be conducted. The treatment zone should now be more uniform in appearance and should also be well centred. Full correction of the refractive error should now have been achieved and there may be a residual hyperopic over-refraction. This occurs because most lenses for orthokeratology are designed to over-correct by 0.50D to 0.75D to compensate for any regression of the effect, which might happen throughout the day. The patient should then be seen a few weeks later and the same routine followed. You should now have consistent results showing good correction and well-centred treatment zones. The patient can now be placed on a six-monthly planned lens replacement programme and the next follow-up appointment should be three months later. At this visit the same protocol should be followed and the patient seen three months later if all is satisfactory. The patient can then be seen at six-monthly intervals when new lenses can be supplied. It is important to check the patient's vision with the lenses *in situ* at least once a year, as this will highlight any changes in refraction. The case study on page 18 shows the changes in correction and topography maps for a patient over a three-month period.

## Fees

Most practitioners who fit orthokeratology contact lenses offer either an annual or six-monthly replacement programme, which is paid by monthly direct debit and covers the cost of the contact lenses, solutions and on-going aftercare. The norm is to charge patients an initial assessment fee of between £200 to £400 to cover the trial of lenses over the first month and then to pay a monthly fee of between £30 to £50 depending on how frequently the lenses are replaced, and whether solutions are included.

Some practitioners, however, choose to charge per pair of lenses, where the overall cost includes professional care and the contact lenses. Patients replace their lenses as and when they want to and can easily spend £700 per pair of lenses.

## Troubleshooting

Almost all lens suppliers will say that they achieve a success rate of between 60 per cent to 80 per cent with the first pair of lenses, and in my experience this is true. The caveat is that you select your patients carefully. They should meet the exclusion criteria, be highly

## MULTIPLE-CHOICE QUESTIONS - take part at [opticianonline.net](http://opticianonline.net)

### 1 Which of the following best defines orthokeratology?

- A The use of planned replacement lenses to slow the progression of ametropia
- B The reduction, modification or elimination of refractive error by the programmed application of contact lenses
- C The flattening of the cornea by use of a flat contact lens
- D The use of 'overminused' lenses to reduce myopic progression

### 2 From the centre to the periphery, which of the following is the sequence of curves for an orthokeratology lens?

- A Reverse curve, base curve, mid-peripheral curve, edge curve
- B Base curve, mid-peripheral curve, reverse curve, edge curve
- C Base curve, reverse curve, mid-peripheral curve, edge curve
- D Base curve, mid-peripheral curve, edge curve, reverse curve

### 3 What is the recommended upper limit for myopia when considering a patient for orthokeratology?

- A -1.00DS
- B -2.00DS
- C -3.00DS
- D -4.50DS

### 4 What is the recommended upper limit for with-the-rule astigmatism when considering a patient for orthokeratology?

- A No astigmatism
- B -0.75DC
- C -1.25DC
- D -1.75DC

### 5 Which of the following is the maximum movement of the lens to ensure a regular defined treatment zone?

- A No movement is acceptable
- B 0.5 mm
- C 1-1.5 mm
- D 2-3mm

### 6 What is the ideal diameter of the area of central touch?

- A 1mm
- B 2mm
- C 3mm
- D 4mm

Successful participation in this module counts as one credit towards the GOC CET scheme administered by Vantage and one towards the Association of Optometrists Ireland's scheme.

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motivated, forgiving, committed to the follow-up schedule and be prepared to pay for the treatment. On the occasions that the first pair of lenses doesn't work, the main complaint is of poor vision at night, flare and haloes. These symptoms generally indicate that the treatment zone is not centred well. Adjustments to the lens diameter and peripheral curves can generally resolve this. Most lens manufacturers and suppliers are only too happy to assist in improving the performance of the lenses. The general rule of thumb is that if you have had three attempts at improving the performance of the lenses and are not satisfied, it is time to try a different approach.

## Summary

Orthokeratology is a life-changing therapy that gives your patients total freedom with the safety of total reversibility. The process naturally occurs in parts of the body. Wearing a ring leaves an imprint of the ring on the finger. This is cell movement caused by hydrostatic forces under the ring. If you leave the ring off for a few weeks then the imprint disappears and the finger returns to its original shape.

Exactly the same happens to the cornea with orthokeratology.

Studies continue to be conducted on the safety of overnight RGP lens wear, but anecdotal results from the Netherlands indicate that orthokeratology is as safe as daily wear hydrogel lenses. The fact that the lenses are removed and cleaned every morning must be a contributing factor.

A topographer is essential for orthokeratology and in my view essential for all contact lens practice. Practitioners need to have a good understanding of topography maps to ensure that they have the best outcomes.

Orthokeratology is ideally suited for low to moderate myopes and fits with the demands of the 21st century lifestyle. It is proven to be effective at controlling the development of myopia. Orthokeratology lenses are only worn at night and used in the home environment. These two factors alone make the procedure a must for our younger patients. Orthokeratology is a practice builder. ●

● Shelly Bansal is a contact lens practitioner practising in north London and a former president of the BCLA