Scleral contact lenses and their therapeutic use – Part 1

There are many misconceptions about scleral lens practice. In the first of two articles, **Jennifer McMahon** aims to answer the most commonly asked questions about the role of scleral lenses and to give an appreciation of their unique place in modern contact lens fitting. Module C17107, one point for contact lens specialists

How should a scleral lens be defined?

A scleral contact lens (ScCL) has its bearing surface on the sclera and is fitted with no or minimal corneal contact. The objective is alignment of the scleral zone with the sclera to create a sealed unit that does not exhibit edge lift as would be observed in both large and regular diameter corneal lens fitting (Figure 1).

Haven't ScCLs been around for a long time?

Yes, ScCLs date back to the late 19th century but then they were made from blown glass. PMMA succeeded glass as the material of choice in the 1940s as it could be heat moulded to replicate an eye impression and lathe cutting techniques could be employed. However, when corneal lenses were developed in the 1950s, ScCLs fell from use as the first choice contact lens option due to the complicated fitting process and the relatively limited oxygen available to the cornea. It was the introduction of RGP materials in the 1980s, allowing the manufacture of non-fenestrated ScCLs, that re-established them as a viable clinical option.

Why are ScCLs an essential tool in specialist lens fitting?

ScCLs have two unique features: a large diameter and scleral bearing which together permit complete vaulting of the cornea and limbus. This means that virtually any corneal topography can be fitted as the lens required is almost irrelevant of the topography itself and is more closely based on the relationship between the projection of the corneal and scleral profiles (Figure 2). The clearance between the lens and the cornea is filled with a fluid reservoir that neutralises any surface irregularity including astigmatism and facilitates simple correction of refractive error. There are also other advantages to ScCLs:

- Their size allows powers of up to ±40D as they are not subject to centre of gravity effects on the eye and are mechanically stable
- The lenses tuck far underneath the lids therefore causing minimal lid sensation and they are rarely dislodged
- They are robust and maintenance is simple as they may be stored dry after cleaning
- Their size can make handling easier for less dextrous patients compared to other lens types.

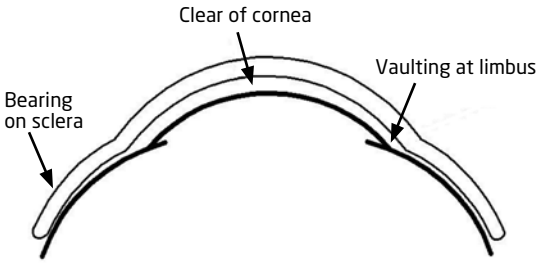


Figure 1 Representation of optimum fitting of a preformed non-fenestrated ScCL

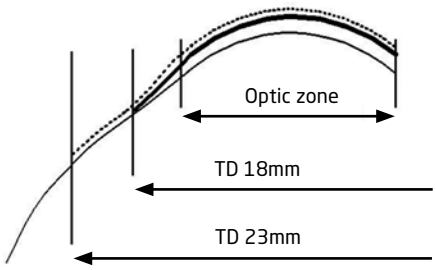


Figure 3 The effect of reducing the diameter: reduced bearing surface, reduced limbal clearance and reduced optic zone clearance

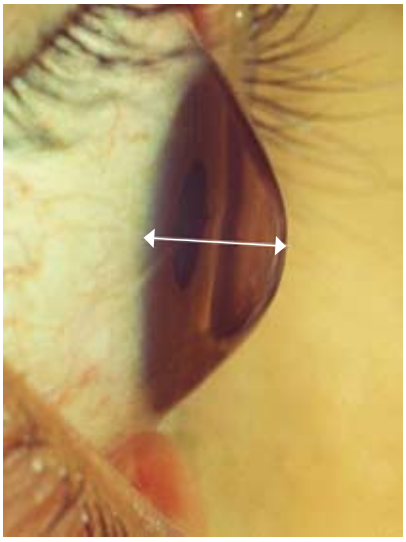


Figure 2 ScCL fitting is based on the relationship between the distension and position of the corneal apex from the scleral plane rather than absolute values of corneal curvature

Why do they have to be so big?

Assuming a corneal diameter of 12mm, a desirable 1mm annulus for both the limbal clearance and the scleral bearing surface itself, then a minimum diameter for the lens to bear solely on the sclera must be 16mm. The upper size limit is defined by the horizontal palpebral aperture size in question – a typical 'full' scleral lens being 23mm in diameter and a 'mini' scleral lens being 18mm. The effect of reducing the diameter from 23mm to 18mm for example, is that the area of the lens that was a transition zone now becomes bearing zone which is also much smaller. This in turn reduces the limbal clearance and the potential for full vaulting of the cornea (Figure 3). Smaller diameter ScCLs may have a tendency to snag on the lower lid during blinking which can be uncomfortable

TABLE 1
Types of scleral lenses

Fitting basis	Material	Fenestration
Preformed trial set	RGP	With or without
Preformed trial set	PMMA	With
Eye impression	RGP	With or without
Eye impression	PMMA	With

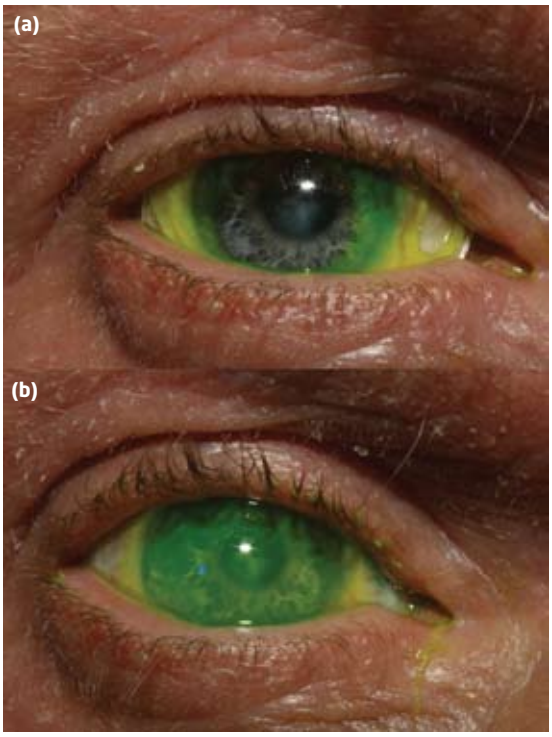


Figure 4 (a) Keratoconus fitted with a fenestrated semi scleral lens demonstrating harsh corneal contact after a short period of wear due to settling back and evidence of apical scarring beneath. (b) Refitted with a preformed non-fenestrated RGP ScCL retaining full clearance throughout wear time

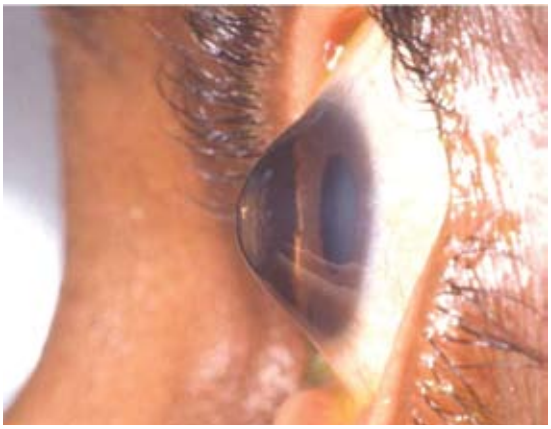


Figure 5 Advanced keratoconus difficult to fit with corneal lenses

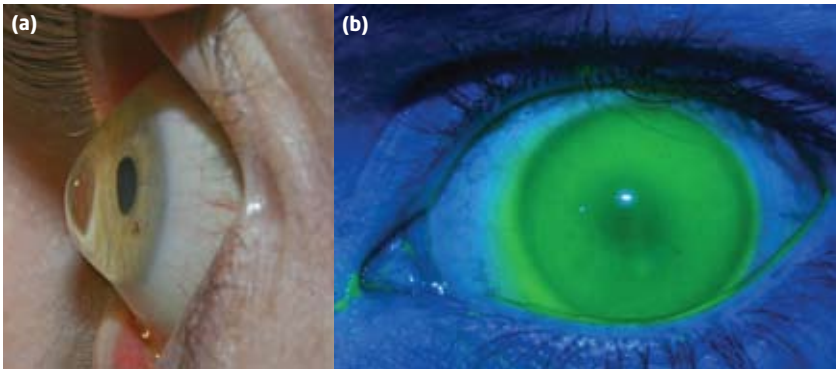


Figure 6 (a) Moderate keratoconus. Corneal lenses were excessive mobile, prone to fall out and poorly tolerated. (b) Full corneal clearance and immediate tolerance with preformed non-fenestrated RGP ScCL

for the wearer and can disrupt the fitting status. However, the advantages of being thinner and lighter as well as having a bearing surface closer to the limbus can be helpful in some instances eg unilateral cases, small eyes or very irregular scleras.

What types of ScCLs are available?

The permutations of ScCLs available are summarised in Table 1.

A non-fenestrated lens has no intentional means to create a clinically significant tear exchange during wear; oxygen is supplied to the cornea only by transmission through the lens material.

So which is preferable – fenestrated[1] or non-fenestrated?

The main advantage of non-fenestrated ScCLs is that they can be fitted with complete corneal clearance making it much easier to fit unusual corneal profiles and also preventing mechanical damage to the cornea and limbus. A fluid reservoir fills the gap between the lens and the cornea, effectively neutralising any anterior corneal surface irregularities and, as it is retained during wear, there is only a minimal settling back effect making the fitting process much more predictable. Furthermore, the troublesome air bubbles admitted by fenestrations that can affect visual quality or cause localised irritation and dehydration for the wearer, are eliminated in the majority of cases (Figure 4). The main disadvantage of non-fenestrated lenses is the need to fill them with saline prior to insertion in the eye.

Although non-fenestrated PMMA ScCLs have been used in the past, the high risk of hypoxia would preclude this as a modern mainstream clinical option. In some cases there may be a valid ▶

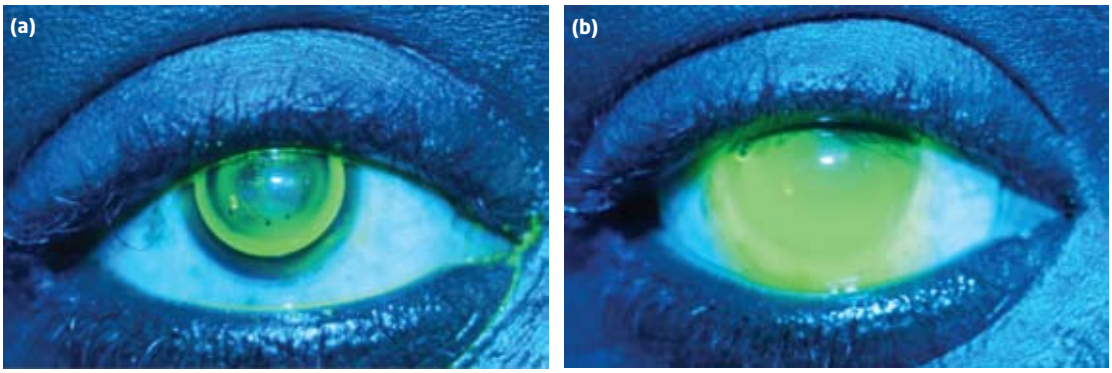


Figure 7 (a) Keratoconus with multiple surface irregularities causing dimple veiling beneath best fitting corneal lens refitte (b) with a preformed non-fenestrated RGP ScCL with full corneal clearance

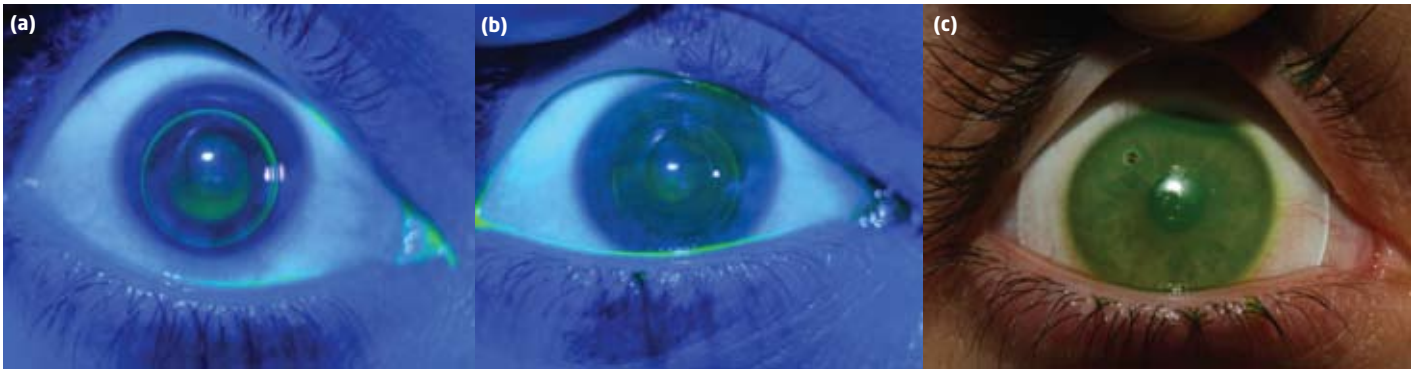


Figure 8 (a) Keratoconus with best fitting corneal lens in situ. The lens binds after only a short period of wear and when the lens is removed (b) the imprint of the lens is still clearly seen. (c) Refitted with a small diameter preformed non-fenestrated RGP ScCL with full corneal clearance

Figure 9 Moderate pellucid marginal degeneration

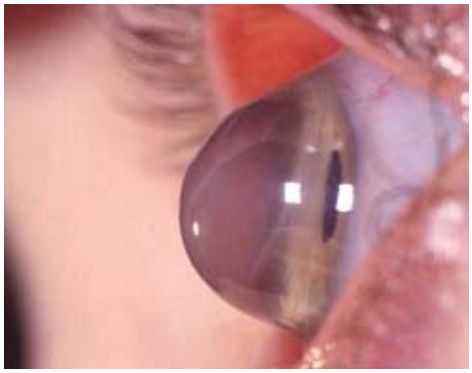


Figure 10 Advanced keratoglobus

clinical indication for fenestration eg the inability to insert a non-fenestrated lens air free, difficulty removing or when PMMA is used; however, the vast majority of ScCL indications can be fitted with a non-fenestrated ScCL of some design.

Preformed or impression?

The modern fitting process for non-fenestrated preformed ScCLs is straightforward and predictable with reproducible results. This will be covered in more detail in Part 2.

ScCLs from eye impression also have their place; however, the fitting process is generally much more time consuming and cumbersome and can give unpredictable results. Examples of indications for impression ScCLs include the failure of preformed designs to achieve satisfactory scleral zone alignment resulting in the introduction of air bubbles into the fluid reservoir during wear and, conversely, unacceptable areas of compression on the sclera.

Don't ScCLs endanger the cornea because of lack of oxygen?

It is acknowledged that there is a reduction in corneal oxygenation with ScCLs and some corneas may be more susceptible to this than others. The thickness of a ScCL must be substantially greater than a corneal lens and there has been concern raised in the past, especially in relation to RGP non-fenestrated ScCLs where there is no clinically significant tear exchange. However, it has been shown that the use of a high Dk RGP material for non-fenestrated ScCLs results in corneal swelling equivalent only to normal overnight swelling.[2,3,4] Therefore if there is a valid clinical indication for ScCLs then they should certainly be tried under the caveat of a continuous and careful follow up schedule.

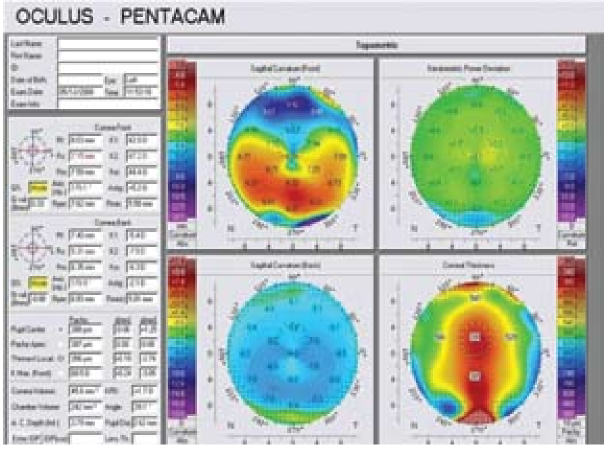
What sort of patients would benefit from ScCLs?

There are several clinical situations where considering a ScCL may be appropriate:[5,6,7,8]

Corneal ectasia

Keratoconus is the main indication for ScCLs.[9] In advanced cases, the corneal topography may be so irregular, or the cone so distended, that it does not lend itself well to satisfactory correction with other lens types (Figure 5). Even in some less advanced cases, it may be that other lenses are unstable on the eye or are poorly tolerated (Figure 6). There can also be other issues such as corneal scarring or erosions that may be exacerbated by the presence of a lens fitting in close contact with the cornea and give the practitioner cause to consider refitting with a different lens type (Figures 7 and 8).

The same applies to other primary corneal ectasias such as pellucid marginal degeneration and keratoglobus (Figures 9 and 10), secondary corneal ectasias such as post refractive surgery (Figure 11) or trauma cases, and corneal degenerations such as Terrien's or Salzmann's. The



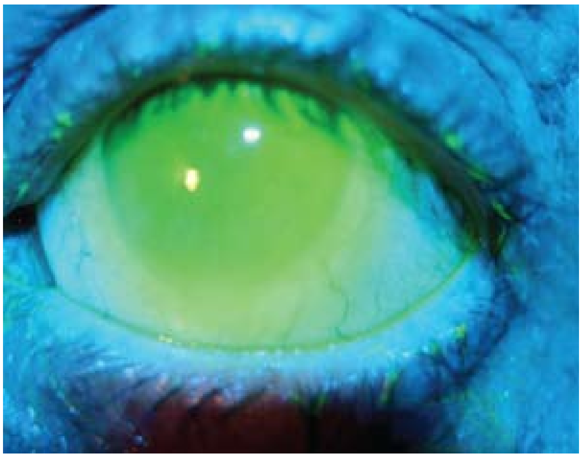


Figure 11 Secondary corneal ectasia following refractive surgery. The irregular topography is easily vaulted by a preformed non-fenestrated RGP ScCL

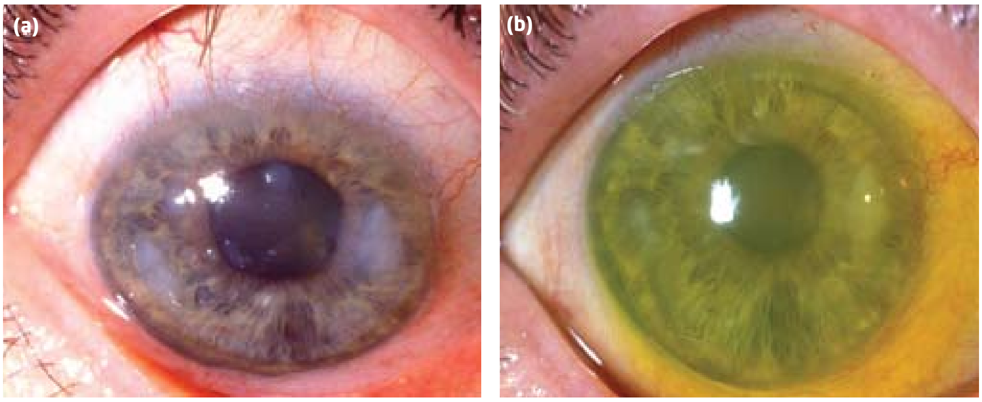


Figure 12 (a) Salzmann's nodular degeneration. Corneal lenses cause discomfort through friction on the raised nodules and spectacles do not provide adequate visual acuity.
(b) Non-fenestrated ScCL in situ providing complete corneal clearance and visual acuity of 6/12

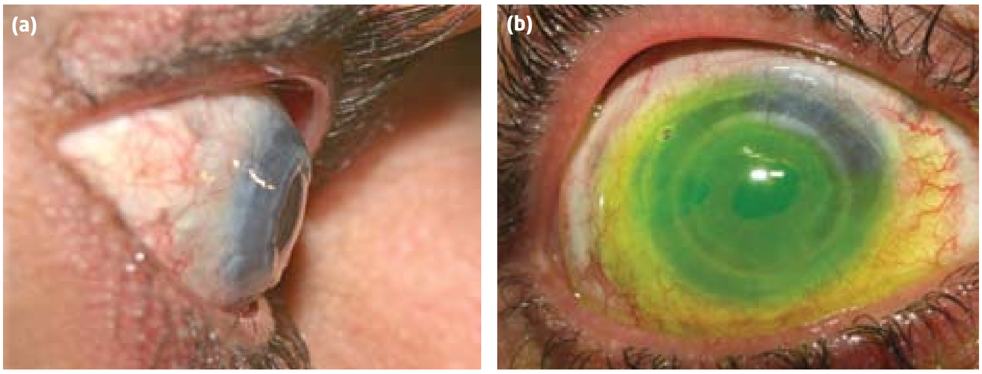


Figure 13 (a) Recessive profile following corneal transplant fitted and (b) with a ScCL *in situ*

latter not only requires neutralisation of surface irregularities created by the nodules but relief from the discomfort caused by a lens or even the eyelids rubbing across them – both of which a ScCL can provide (Figure 12).

Post corneal transplant

This is the second largest group of ScCL wearers.[9] When corneal ectasia is the indication for surgery, although the central corneal topography may be much more regular postoperatively, there may still be significant astigmatism, peripheral irregularities or an unusual profile present (Figure 13). In such cases it can be difficult to fit a corneal lens satisfactorily, avoiding, for example, touch on the central cornea, contact on the graft-host margin, excessive lens mobility etc, whereas a ScCL can vault the entire area thus preventing such issues and protecting the graft (Figure 14).

Therapeutic

In recent times there has been an increase in the use of ScCLs in the management of some ocular surface diseases.

In severe dry eye or mucosal dysfunction conditions such as Stevens

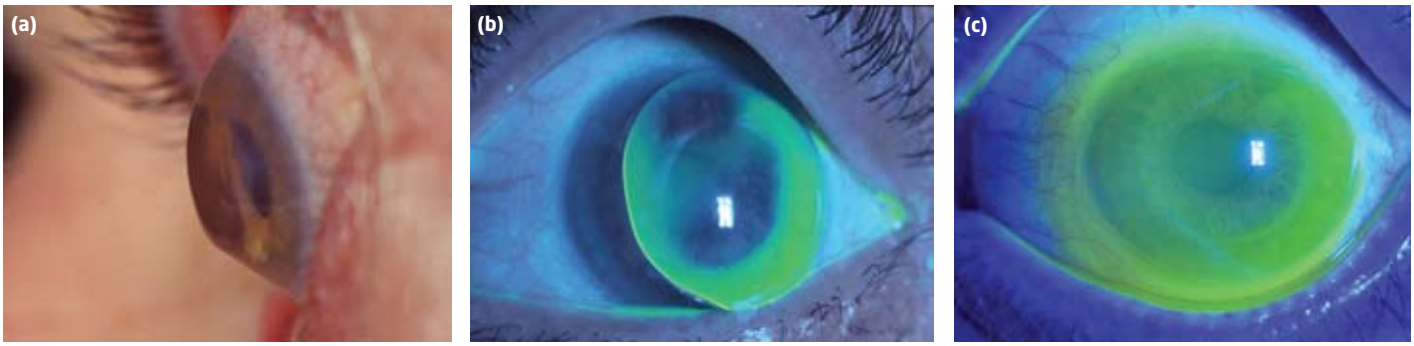


Figure 14 (a) Post graft cornea. (b) Fitted with a corneal lens. (c) Full corneal clearance and centration achieved with a preformed non-fenestrated ScCL

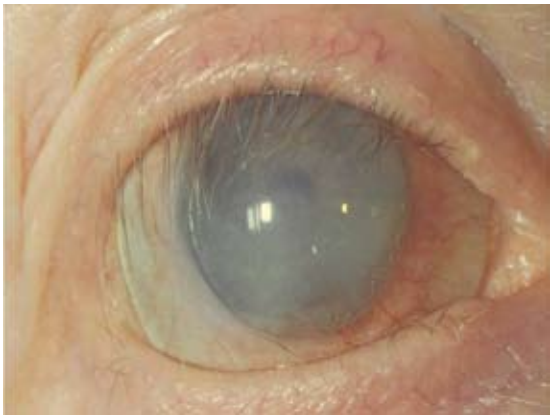


Figure 15 Stevens-Johnson syndome. Preformed, non-fenestrated RGP fitted providing hydration from the fluid reservoir and also protection from the metastatic lashes

Johnson Syndrome, ocular cicatricial pemphigoid, graft-versus-host-disease and Sjögren's syndrome, the fluid reservoir retained between the cornea and the lens can provide corneal hydration when other therapeutic lens types may become dislodged, degraded or intolerable as a result of the poor tear quality (Figure 15).

The large diameter and full corneal clearance means that ScCLs can protect the cornea from the friction of eyelid movement and thus can have a role in the management of epithelial defects[10] where continuous sloughing of the epithelium may be preventing healing and may not be assisted by the moving and contact nature of other lens types. Similarly the large and rigid nature of ScCLs can protect the cornea from mechanical damage due to trichiasis (Figure 16), the effects of lid margin disease or environmental factors such as dust. ScCls can be used as an alternative bandage contact lens in corneal decompensation (Figure 17) and anaesthesia consequent to CNV (trigeminal) nerve damage may also benefit from the unique and total protection provided.

For those with incomplete lid closure and therefore at risk of exposure keratitis, for example in VII (facial) nerve palsy, lid trauma, ectropion and exophthalmos, ScCLs can be an effective solution as they preserve the tear film, protect the structures beneath and are much less susceptible to alteration by environmental factors than other lens types in the absence of an effective lid action. ScCLs have been used for overnight wear in appropriate circumstances[11] and may be justified more so in poor lid closure cases as the hypoxia risk would be reduced compared to a full closed eye situation.

Another use for ScCLs is in ptosis where the upper lid can be supported by means of a shelf added to or cut into the lens or by using a thicker shell to prop the lids open. The latter form may also be used in enophthalmos to increase the palpebral aperture size (Figure 18).

Other uses

There are also smaller groups who can be successfully fitted. ScCLs can be used for various contact and/or water sports as the lenses are not easily dislodged, for the correction of high refractive

MULTIPLE-CHOICE QUESTIONS – take part at opticianonline.net

1 Which of the following statements about the properties of scleral lenses is not true?
A They may correct errors of up to 40 dioptres
B Their large size causes significant discomfort due to lid contact
C Handling of scleral lenses may be easier than smaller corneal lenses
D They may be stored dry

2 What is the main advantage of non-fenestrated scleral lenses?
A They are easier to orientate on the eye
B There is less risk of hypoxia
C They can be fitted with complete corneal clearance
D They do not need to be saline-filled prior to insertion

3 Which of the following statements is true about the Saltzmann's degenration and scleral lenses?
A The condition makes contact lenses inappropriate
B The rigid lens helps depress the nodules
C The lens provides relief from mechanical impact on the nodules by, for example, blinking
D The smaller the lens, the better the comfort

4 Which of the following is not a cause of ectasia?
A Refractive surgery
B Pellucid marginal degeneration
C Keratoglobus
D Fuch's endothelial degeneration

5 Which of the following is not correct regarding smaller diameter ScCLs?
A They can be as small as 14mm in diameter
B They can be useful in unilateral cases
C They are thinner and lighter
D They may snag on the lids and cause discomfort

6 Which of the following is key to accurate scleral fitting?
A HVID
B Pupil diameter
C Projection of corneal apex from the scleral plane
D BOZR

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The deadline for responses is July 28 2011

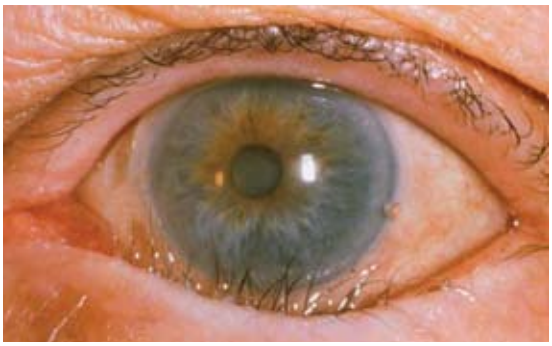

Figure 16 Fenestrated PMMA ScCL in situ protecting the globe from lashes in entropion

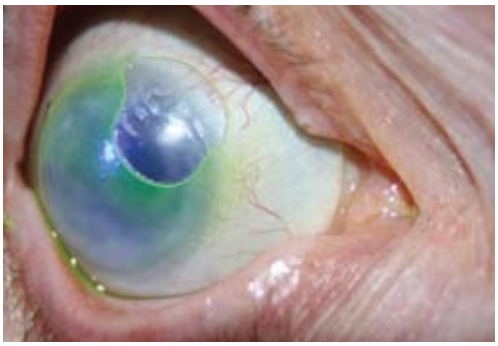

Figure 17 Corneal decompensation with macrobullae secondary to complicated cataract surgery. All types of soft bandage contact lenses tried fell out, now happily wearing fenestrated preformed ScCL

error when handling or potential for infection is a concern with other lens types, or as the basis of a sighted or non-sighted cosmetic shell.

Summary

ScCLs may be applied in any clinical situation where their unique design features of large diameter, scleral bearing and corneal clearance would be advantageous. They provide a vital alternative when other contact lens types do not give a satisfactory outcome or are not appropriate.

Part 2 in this series will address clinical issues of current fitting techniques.

Figure 18 (a) Young female with right enophthalmos secondary to radiotherapy treatment. (b) Thick preformed non-fenestrated RGP ScCL in situ propping the lids open for improved cosmesis

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