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The role of therapeutic contact lenses in corneal wound healing

The use of therapeutic contact lenses (TCLs) is a well established technique in modern ophthalmological practice. They have proved to be an extremely effective tool in the management of a wide variety of ophthalmic disorders. Such lenses may be used to return abnormal tissues (usually the cornea) to a more anatomical and functional state. TCLs are most commonly used to relieve pain, promote healing and provide mechanical protection and support during healing. Sometimes they can also be used as a means of drug delivery. Very often the aims of TCL wear are a combination of the above.

In many ophthalmic conditions, the use of TCLs is not the only treatment modality as several management options are available. This article will discuss the most common ophthalmic conditions encountered where TCLs have been shown to be useful. Other alternative management options will also be discussed where appropriate. One of the most commonly encountered conditions where TCLs can sometimes have a role to play is in recurrent corneal erosion.

RECURRENT CORNEAL EROSION (RCE)

Recurrent corneal erosion (RCE) is a distinct clinical entity characterised by repeated episodes of spontaneous breakdown of the corneal epithelium. This relatively common disorder was first reported in 1872[75]. There are several causes of recurrent corneal erosion and an aberration in normal adhesion complexes is a common factor to all of these. Currently, RCE is classified as primary or secondary depending on whether the defect in the epithelial basement membrane is intrinsic or acquired[76].

Symptoms in RCE include foreign body sensations, pain, epiphora and photophobia. The most common time of onset of symptoms is usually on first awakening or in the early hours of the morning during rapid eye movement (REM) sleep. This is thought to be due to the low tear production during sleep, rendering the eye relatively dry. This is in contrast to symptoms of dry eye that occur more commonly at the end of the day[82].

When deciding on the best mode of treatment for recurrent corneal erosions, it is important to first establish whether the cause is due to one of the anterior basement membrane dystrophies, i.e. intrinsic, or acquired i.e. traumatic. This is because the subsequent management is different in each case[77,78].

Part 2

PRIMARY – EPITHELIAL BASEMENT MEMBRANE DYSTROPHY (EBMD)

EBMD can produce intermittent epithelial breakdown and is associated with corneal surface and wetting problems. Also known as map dot finger print dystrophy **(Figures 1a and b)**, it is the most common dystrophy to cause corneal erosion problems[79,80]. There are, in fact, several other corneal dystrophies that have similar effects. In EBMD, the basal epithelial cells manufacture abnormal finger-like projections that protrude from the abnormally thickened basement membrane. These projections reduce adherence of the overlying epithelium thus producing the characteristic changes. Fibro-granular ridges associated with and adjacent to these extensions form the finger print patterns seen in map dot finger print dystrophy[81]. These protuberances bend in the epithelium, trapping cells and intracellular debris to form microcysts[82]. When a series of microcysts become grouped together and migrate forward, corneal surface abnormalities and RCE occur. Although most patients remain asymptomatic throughout life, approximately 10% develop recurrent erosion syndrome.

Figure 1a

Figure 1b Map dot finger print dystrophy (by courtesy of Stephen Morgan, SEI)

SECONDARY – TRAUMATIC RECURRENT CORNEAL EROSION

Recurrent corneal erosion is a commonly encountered condition in ophthalmic casualty departments as well as in ophthalmic out-patient clinics **(Figure 2)**. The most frequent cause of recurrent erosion is minor trauma or abrasion produced by, for example, fingernails, contact lenses, hair brushes, tree branches, dust and the like. Other possible causes include thermal and chemical injuries that damage the epithelial basement membrane complexes as well as degenerative corneal conditions such as Salzmann's nodular degeneration or band keratopathy[76].

PRINCIPLES OF MANAGEMENT

The immediate treatment goal of an acute corneal epithelial erosive episode is to promote epithelial regeneration and re-establish an intact ocular surface. This often must be maintained for sufficient time to

Figure 2
JF: Epithelial breakdown due to RCE, successfully managed with a Lunelle 8.60/14.00/plano T for one month

allow reformation of the normal basement membrane complexes responsible for tight adhesion[83].

It is neccesary to record a detailed history. During the history taking, it is important to establish the underlying cause as well as the existence of any other external eye disease and whether the cornea is actually infected. Checking the family history is important for similar episodes as well as checking the fellow eye for signs of corneal dystrophy. It is important, however, not to confuse epithelial cysts or dots, which are characteristic of newly healed epithelium, with signs of anterior basement membrane dystrophy[84].

An attempt at recording visual acuity should be made. If intense blepharospasm precludes acuity testing, the instillation of one drop of anaesthetic should be considered. For an abrasion, first evert the eyelid and examine the palpebral conjunctiva, ocular surface and fornices to rule out the presence of a foreign body. The area of erosion may appear like a wrinkled carpet or even as a frank epithelial defect. The size of the epithelial defect can be determined with the instillation of fluorescein **(Figure 3)**.

The choice of treatment option depends on the cause, the location of the defect, i.e. axial or off-axis, presence of other pathology, resources available and the reliability of the patient to adhere to treatment regimens deemed appropriate[84].

In the first instance, recurrent erosions are nearly always treated with ocular lubricants. A cycloplegic agent may also be considered to help relieve pain. Loose flaps of epithelium should first be removed before prescribing lubricants. If pain is severe the patient may need topical non-steroidal anti-inflammatory drugs (NSAIDs), e.g. Voltaren[82]. There is no definite evidence to suggest that the use of NSAIDs inhibits the wound healing process. The benefits of patching are controversial. Certainly, patching makes topical administration of drops more difficult and is also more inconvenient for the patient. Larger abrasions, however, may well benefit from patching, or perhaps a therapeutic soft contact lens (see later) **(Figure 4)**. Ideally, the patient should be checked every 24 hours until the defect has re-epithelialised.

Figure 4
RW: Large epithelial defect due to RCE, successfully managed with a PBH Precision UV disposable contact lens

The prescribing of an antibiotic such as, for example, chloramphenicol is very important to prevent infection of the wound until the corneal surface is re-epithelialised.

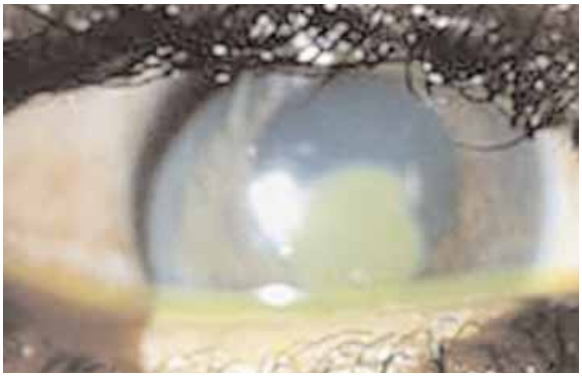
If the corneal epithelium is not healing properly within 24 to 48 hours, debriding the area to give the epithelium a 'clean surface' on which to regenerate may help[85].

Once an abrasion has healed and the patient is asymptomatic, lubricant therapy is normally continued as a prophylactic measure for a minimum of six months. Sometimes, hypertonic saline (NaCl 5%) is used as well, particularly where microcysts are present, to reduce corneal swelling.

Although not commonly used, corneal changes of EBMD patients can be closely monitored with keratometry (checking mire quality in particular). Signs of dry eye should also be assessed such as tear film quality and wetting stability. If dry eye is a problem, punctal plugs may also be of benefit in certain cases.

For severe, recalcitrant cases, other management options include: superficial keratectomy; anterior stromal puncture (ASP); therapeutic contact lenses (TCLS); or in certain circumstances, photo therapeutic keratectomy (PTK).

Figure 3
Fluorescein staining of a corneal abrasion (by permission from Review of Optometry On-line)



SUPERFICIAL KERATECTOMY

In eyes with recurrent erosion or decreased vision secondary to EBMD, partial superficial keratectomy is the preferred treatment option[77,78]. This method is indicated in cases that involve the entire corneal surface as in EBMD. The aim of treatment is to remove the abnormal basement membrane by scraping the cornea. The limbus should be left untouched in order to avoid damaging the regenerative stem cells[76].

ANTERIOR STROMAL PUNCTURE (ASP)

ASP is very often useful in post-traumatic abrasions that have not responded positively to lubcricant therapy. ASP encourages plugs of epithelium to grow through breaks in Bowman's layer into the superficial stroma where new adhesion complexes may form[79]. ASP is appropriate for off-axis lesions owing to the faint scarring which occurs that may otherwise affect vision. Faint scarring in the peripheral cornea is of no significant visual consequence. This procedure is best performed using a fine 27-gauge needle[82,86,87]. An alternative is to use a YAG laser to perform ASP which is said to be more reproducible than with a needle and apparently produces less scarring[88,89].

EXCIMER LASER PHOTOTHERAPEUTIC KERATECTOMY (PTK)

Reports to date on the use of excimer laser, PTK, for healing problem cases of recurrent corneal erosion have been very encouraging[90,91,92] **(Figure 5)**. The exact mechanism by which the excimer PTK exerts its effect is unknown. However, it probably modifies the surface structure of the basement membrane and Bowman's layer biomechanically to enable stronger cell anchorage to occur. Excimer laser ablation of the cornea is applied following epithelial debridement[93]. The surface to be ablated should be wiped clean first, using a

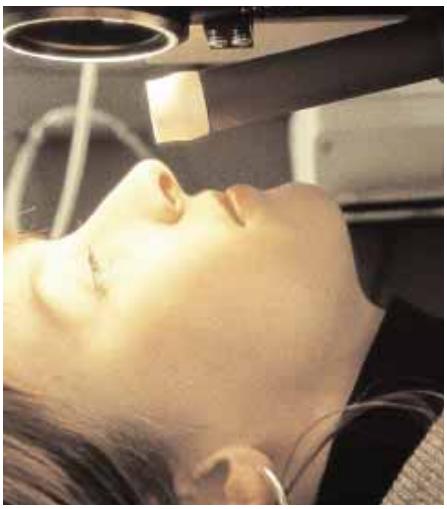


Figure 5
Patient undergoing PTK with the VisX 20/20 excimer laser

triangular sponge, to avoid etching irregular surface profiles onto the cornea. Ablation areas of any size may be undertaken but the limbal epithelium should be avoided as this is where the limbal stem cells are situated. The required ablation depth is as little as 2-3µm which equates to approximately 10-12 laser pulses, lasting no more than a few seconds. When treating an axial area, the eye must be kept still during ablation to help minimise any unwanted refractive changes that can result[94]. Post operatively, there may be a small hypermetropic shift in refraction and many patients enjoy a slight improvement in vision due to the removal of opacties in the cornea[94]. However, the main concern is loss of Snellen lines of best corrected visual acuity due to the post-operative induced corneal haze.

THERAPEUTIC SOFT CONTACT LENSES

Although the use of TCLs may be useful here, the risks of complications, particularly microbial keratitis, have to be very carefully considered. There are a number of other conditions that may compromise the successful use of a TCL, including tear deficiency, marginal blepharitis and conjunctival inflammation from, for example, atopic keratoconjnctivitis and cicatrising conjunctivides.

In dystrophic cases, recurrence is quite common despite the use of a TCL anyway. In some cases, patients just cannot tolerate a TCL *in situ* especially in the acute post-injury phase[79].

TCLs are particularly useful in large abrasions to relieve pain and to protect loosley adherent epithelium from the abrasive action of the eyelids so that epithelial healing can occur. In general, the following points should be considered during the fitting of a TCL.

- Commonly, a TCL will be used on an extended wear basis for two, three or even six months, with removal and/or replacement only as necessary. If a patient has been wearing a TCL for three months or more, however, and is completely symptom free, it is advisable to remove the TCL and re-commence conventional lubricant treatment[79].
  The use of a TCL on an extended wear basis may well induce long-term hypoxic changes within the cornea resulting in, for example, corneal neovascularistion.
- Ultra-thin TCLs are contraindicated due to possible buckling or wrinkling of the lens with lid movement, thus producing an ineffective corneal splint action[95].
- A thick, high water content extended wear lens is preferred, as it will produce an effective splint and not over compromise corneal metabolism. 'Disposable' lenses are recommended for the management of corneal erosion[96,97].

TRAUMATIC CORNEAL ABRASIONS AND TCLS

Abrasions over 4mm may well benefit from the use of TCLs, where the epithelium reportedly heals more quickly, compared to the conventional methods of treatment discussed earlier[98,99]. Certainly in the United States, the use of TCLs post photorefractive keratectomy (PRK) is common in order to relieve pain and promote epithelial healing. In the UK, however, the use of TCLs following PRK has never been routinely adopted.

Disposable lenses such as Precision UV (WJ) and ACUVUE (J&J)[96] have been shown to be successful in the treatment of corneal abrasions.

PERSISTENT CORNEAL EPITHELIAL DEFECTS AND TCLS

Persistent (non-healing) corneal epithelial defects (PEDs) are a chronic management problem. A PED leaves the cornea more vulnerable to infection and is, therefore, associated with a high rate of ulceration and perforation. TCLs, e.g. 'disposables', can provide mechanical protection from the lids whilst new epithelium re-attaches to the newly secreted basement membrane[102].

In experimental studies, collagen shields hydrated in acidic fibroblast growth factor (aFGF) have been shown to promote epithelial wound healing in such cases[103,104].

TCLS IN THE MANAGEMENT OF CHEMICAL INJURIES

Chemical injuries may suffer severe stromal ulceration mainly due to the collagenolytic activity unleashed, although other processes are also involved. The presence of a TCL may inhibit the passage of certain proteolytic enzymes present in the tear fluid to the stroma, thus preventing the progressive ulcerative process following chemical injuries[102].

A chemical burn to the eye is often associated with chemosis as well as the epithelial damage **(Figure 6)**.

Therefore, a small total diameter TCL is the lens of first choice (TD~12.5mm). If there is a peripheral corneal ulcer with an

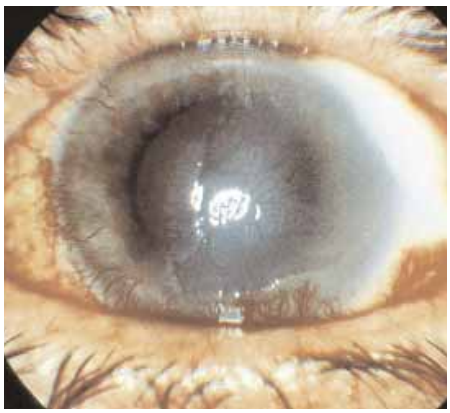


Figure 6
Large epithelial defect due to an alkali burn

epithelial defect, a low water content TCL is advocated in order to promote corneal vascularisation. In peripheral corneal ulcerations, such as chemical injuries, Mooren's ulcers and corneal melts caused by connective tissue disease, the anoxia and slight trauma caused by a TCL may stimulate vascular ingrowth **(Figure 7)**. Subsequent stromal vascularisation may arrest the ulcerative process[103,104].

POST-OPERATIVE EPITHELIAL DISORDERS

Many ophthalmic surgical procedures can result in corneal epithelial defects. These include:

- vitrectomy (in ~25% of diabetics)[105];
- post penetrating keratoplasty in the early post operative period **(Figure 8)**;
- epikeratoplasty **(Figure 9)** and lamellar grafts;

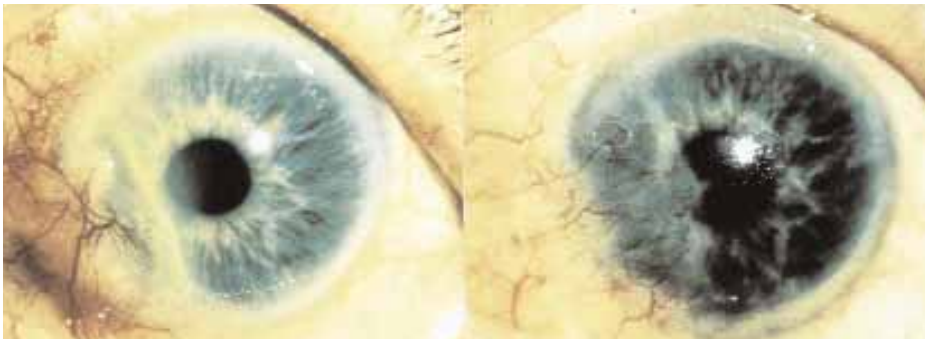


Figure 7
Mooren's ulcer (left) and again seven months later after the use of a soft bandage lens (in 'Contact Lenses', Eds: Ruben and Guillon, by permission from Arnold)

- kerato-refractive procedures e.g. PRK, LASIK; *and*
- cataract extraction (wound leakage i.e. positive Seidel's test) **(Figure 10)**.

Soft and collagen TCLs may be utilised in order to minimise post-surgical epithelial trauma, provide a stable healing environment and promote rapid healing.

Figure 8
Leaking graft junction temporarily managed with a mega-soft TCL

Figure 9
Epikeratophakia with a PED after one week, successfully managed with a soft TCL (by courtesy of Professor E.G. Woodward, City)

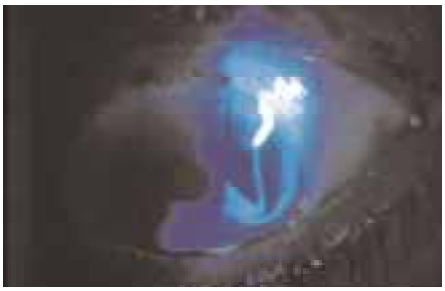


Figure 10
Positive Seidel's test following ECCE cataract surgery

PENETRATING KERATOPLASTY (PK)

There a number of possible uses for a TCL following a corneal graft[106]:

1. Where an existing graft has perforated, a TCL may be used to reform the anterior chamber.
2. Delayed epithelial healing of more than one week.
3. Epithelial filament formation.
4. Steps in host graft junction.

CORNEAL LACERATION

With small perforations (less than 2mm) without tissue loss **(Figure 11)**, structural support may be achieved and the integrity of the eye maintained, by the utilisation of a TCL[107,108].

The healing rate is quicker in small lacerations and for those that are not infected. Perforations close to the limbus and those in vascularised areas respond most favourably to the application of TCLs.

Figure 11
Partial thickness laceration (lower right), successfully managed with a WJ Precision UV disposable lens

Some clinicians advocate the use of cyanoacrylate (tissue) glue as the treatment of first choice in cases of corneal perforation[109] **(Figures12 and 13)**. A thin, low water content TCL will provide protection to this adhesive plug over the corneal wound and from the shearing effects of lid action. This can be a temporary measure prior to surgical repair.

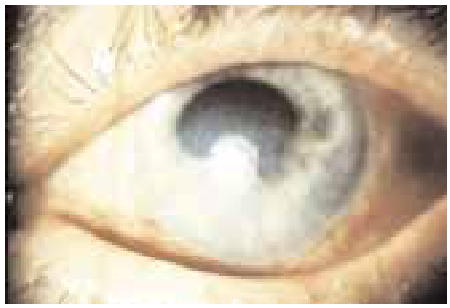


Figure 12
AS suffers severe rheumatoid arthritis and has had several episodes of corneal melting. Here the central corneal perforation has been sealed with tissue glue with a soft TCL protecting the lids.

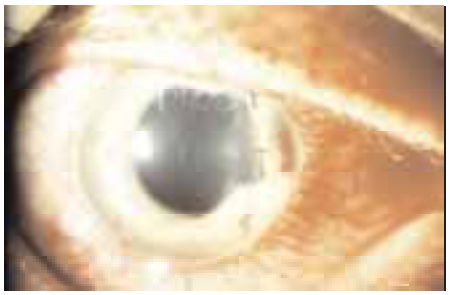


Figure 13
Large corneal laceration with protruding sutures made comfortable by the insertion of a large, soft TCL

Partial thickness corneal lacerations involving stroma, with the wound edges well appositioned, can be treated with a TCL quite successfully with resulting small scars at the entrance sites. A small perforation near the visual axis may heal with less resultant astigmatism if a TCL rather than a suture is used. A thin low water content soft lens would be the lens of first choice.

COMPLICATIONS WITH TCLS

The complications of extended wear TCLs are similar to those of cosmetic extended wear lenses. The compromised nature of the eye needing therapeutic application of lenses does not seem to alter significantly the incidence of lens complications as a whole[110].

The use of prophylactic antibiotics with TCLs may be beneficial in the short term, although this remains highly controversial. Microbial keratitis **(Figure 14)** is the most serious complication of contact lens wear and ulcers induced by TCL wear pose a serious problem.

It is also important to look out for giant papillary conjunctivitis (GPC) and neovascularisation, particularly during aftercare visits.

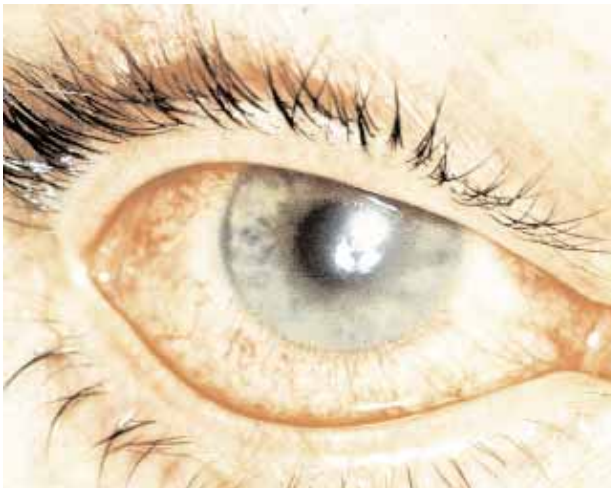


Figure 14
Microbial keratitis

SUMMARY

Following on from the review of corneal wound healing in Part 1 (*Optometry Today*, 24/9/99), Part 2 of this article has discussed the use of TCLs in a wide variety of ophthalmic conditions where their use can relieve pain, promote corneal wound healing and provide mechanical protection and support. In particular, recurrent corneal erosion (RCE) was discussed. The presentation of the various types of RCE have been described as well as the principles of managing such cases in practice. Most cases respond well to conventional lubricant therapy and hypertonic saline. For severe or recalcitrant cases other treatment options have been discussed including the use of TCLs.

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For a full set of references, please fax 01252-816176