CHAPTER 20

THERAPEUTIC USE OF CONTACT LENSES

Cornelius Celsus (see inflammation chapter 16) in the first century A.D., was the first to apply a honey-soaked linen bandage to the eye, after a pterygium excision to prevent the formation of symblepharon [89]. During the 1880s, Eugene Kalt fitted a keratoconus patient with a therapeutic lens [89]. With the advent of pHEMA material in the 1970s, soft contact lenses could be successfully used as bandage lenses [1].

Bandage contact lenses are fitted to protect the cornea, to reduce pain, to improve vision when the corneal shape is distorted, and to promote corneal healing in a pain free environment. Soft contact lenses can also be used as drug delivery devices to the eye and this will be discussed later in this section.

INDICATIONS FOR BANDAGE LENSES

Unusual or Distorted Corneal Shape

RGP and mini-scleral lenses, as well as specialised soft lenses, can be used to correct irregular astigmatism caused by conditions such as keratoconus, pellucid marginal degeneration, iatrogenic ectasia and any other conditions that may cause irregular corneal shapes that affect vision. This is dealt with in more detail in chapter 13. Bandage contact lenses can be used successfully for conditions, such as filamentary keratitis, a disorder of irregular epithelial turnover that causes mucous filaments to adhere to focal epithelial micro-erosions of the cornea. The bandage lenses provide comfort and decrease the formation of new filaments by reducing epithelial desquamation [571]. In these cases, extended wear bandage lenses may have to be worn for weeks or months with concomitant use of topical antibiotics [398]. Contact lenses can also be used to alleviate the discomfort associated with other surface disorders, such as Thygeson's superficial punctate keratitis and superior limbic keratitis [571].

Pain Relief

Pain from corneal injury can be severe and disabling. In the past, pressure patching in conjunction with medial therapy, such as antibiotics and cycloplegics, were extensively used to alleviate pain and prevent secondary infection when treating these injuries. However, pressure patching is rarely necessary and should not be used if the injury is from vegetative matter, finger nail scratches or contact lenses. Extended wear bandage contact lenses can be used to treat corneal abrasions, but concurrent use of prophylactic antibiotics are advocated to avoid microbial keratitis and the patient should be followed up on a daily basis for evaluation and lens replacement if necessary [398]. The bandage lens acts as a barrier between the lid and the injured cornea preventing further mechanical injury and reducing pain [89].

Recurrent Corneal Erosions (RCE)

Recurrent corneal erosions usually manifest with blurred vision, photophobia, pain and discomfort. Slit-lamp findings, may include epithelial microcysts, loose epithelial attachments and map dot fingerprint dystrophy at the

level of the basement membrane (also known as epithelial basement membrane dystrophy) [398]. Several different conditions may cause recurrent corneal erosions [571]. They include:

- Epithelial basement membrane dystrophy
- Reis-Bucklers dystrophy
- Trauma
- Stromal dystrophies (e.g., granular and lattice dystrophy)
- Bullous keratopathy (both aphakic and pseudophakic)

The pathophysiology of RCE disorder is abnormal epithelial basement membrane adhesion complexes, focal basal epithelial oedema and abnormal epithelial turnover. Bullous keratopathy is caused by endothelial failure that results from corneal stromal oedema, corneal epithelial oedema and epithelial bullae. The bullae cause epithelial fragility and subsequent rupture from the trauma of eyelid movement. Breakdown of bullae is painful and places the cornea at risk for infection [571].

Bandage contact lenses decrease trauma to the fragile epithelium, caused by the constant movement of the eyelid and provide a smoother surface and lubrication by an even tear film for the pain free healing epithelium. By protecting the exposed nerve ending from exposure and the shearing effects of the eyelid, pain and discomfort is significantly reduced [89, 571]. Extended wear bandage contact lenses with a topical antibiotic, should be used for several months until epithelial adhesion is obtained [398]. Patients should be followed up ever 1–2 days until the epithelium has healed and then 1–3 monthly depending on the severity and frequency of the episodes [398].

Corneal Ulcers

Bandage contact lenses occasionally are used in the management of corneal ulcers and can be applied in the treatment of infectious, trophic and autoimmune-related ulcers, such as Mooren's ulcer. A soft lens can provide protection of the fragile healing corneal epithelium, while maintaining effective delivery of antibiotics via a depot mechanism. A trophic corneal ulcer usually presents as a persistent epithelial defect with possible stromal ulceration and can be associated with decreased corneal sensation [571]. Trophic ulcers are normally non-infectious, but secondary infections may occur [571]. The goals in treating these lesions are to promote epithelial healing and to prevent secondary stromal ulceration. Using a silicone hydrogel soft contact lens with high oxygen permeability may provide protection for the healing epithelium [571]. Mooren's ulcers or peripheral ulcerative keratopathy is a thinning disorder of the corneal stroma that often is associated with an autoimmune aetiology [398]. Immune mediators cause collagen destruction of the stroma, which may lead to severe thinning and perforation of the cornea. The condition presents with pain, photophobia and redness. Lesions are treated as infectious until proved otherwise [398]. A bandage lens can provide protection of the healing cornea and can promote stromal vascularisation to prevent further melting [571].

Dry Eye and Keratitis Sicca

Using soft bandage contact lenses for cicatrising and dry eye conditions remain controversial [571]. The goal of therapy in these states is to maximise lubrication and the tear function of the eye, while maintaining the integrity of the ocular surface [571]. Although a hydrogel lens may protect the conjunctival and corneal epithelium from exposure and trauma of the eyelids, it also can predispose the eye to infections. Some hydrogels may worsen the dry eye state by dehydrating the cornea and conjunctiva as the lens material seeks to maintain its specific water content [89]. Aggressive lubrication along with prophylactic antibiotics and careful follow-up must be used in treating these patients [398]. Scleral lenses provide a tear reservoir without touching the cornea, and can therefore be used in cases of severe dry eye, cicatrical conjunctivitis, Stevens-Johnsons syndrome and ocular phemhigoid to protect the cornea from the hostile environment created by the disease [89].

Postoperative Complications

Bandage contacts lenses can be an extremely valuable adjunct when treating postoperative conditions of the cornea and ocular surface. Bandage lenses can aid in epithelial healing after the planned surgical removal of the epithelium for procedures, such as epithelial basement membrane disease, anterior corneal scar removal, phototherapeutic keratectomy, photorefractive keratectomy and laser sub-epithelial keratomileusis (LASEK). The bandage lens protects the healing epithelium, provides significant pain relief in the postoperative period and may decrease possible sub-epithelial scar and haze formation by shielding the bare underlying stroma from the constant mechanical trauma of the eyelid [571]. Bandage lenses are also used to treat epithelial defects after penetrating keratoplasty, iatrogenic epithelial defects from a microkeratome pass during LASIK surgery and after using cyanoacrylate adhesive for corneal perforations. Small aqueous leaks following surgery (Seidel's sign) or trauma can often be sealed by using a bandage lens until the anterior chamber reforms and the cornea steepens [89]. Bleb-related complications, leaks and enlargement in cases of hypotony, after glaucoma surgery can also be managed using a bandage lens [89, 571] [572, 573].

CONTRAINDICATIONS FOR THERAPEUTIC LENS WEAR

The single most important contraindication against the use of a contact lens is corneal anaesthesia [571]. If a significant decrease in corneal touch sensitivity occurs, the eye does not tolerate the contact lens well, and can develop significant inflammation and potential corneal infiltration. Another relative contraindication is significant lagophthalmos or lid-position abnormality [571]. The localised drying of the contact lens can cause mechanical irritation and abrasion on the surface of the eye, as well as significant discomfort [89].

As discussed previously in chapter 16, contact lenses can alter the normal ocular surface and tear film significantly [442]. Another controversial issue is the alteration of the microbial flora of the normal conjunctiva with contact lens use [574]. Because there is an increase in the risk of infectious keratitis with therapeutic lenses [398], topical antibiotics should be considered for prophylaxis, when using a therapeutic contact lens. In conditions where a therapeutic lens is left in place for an extended period of time, removing the lens periodically and cleaning it with solutions to avoid protein and microbial build up is the best course of action [571].

The complications of therapeutic lens wear are similar to that of "normal" contact lens wear, and a detailed discussion can be found in chapter 16.

WHICH LENS SHOULD BE USED?

If the therapeutic goal is protection and healing of the corneal epithelium, epithelial or stromal oedema should be avoided, and the selection of a high-Dk/t silicone hydrogel lens is the best choice [575]. If the goal is surface protection, as well as stimulation of stromal wound vascularisation, selection of low-water content, thick, hydrophilic lens is the better option [575]. If the patient is prone to lens loss or requires frequent replacement of the therapeutic lens, a prudent economic decision is to select a daily disposable moderate-water content lens [575]. Patients who have dry eye may benefit from a higher-water content lens, if adequate unpreserved tear supplementation is provided with or without punctal occlusion [575]. Not all available disposable lenses are FDA-approved for therapeutic use, and therefore such wear is considered an off-label use. Make sure that the patient is informed of the goal of therapy, as well as the benefits and risks of therapeutic contact lenses [575].

The following case illustrates the benefits of a bandage lens in conjunction with medical therapy.

A 58-year-old Caucasian female, presented with a history of trying to clean a dark spot on her ceiling using a household cleaner, which she splashed onto the ceiling and obviously into her eye while looking up. She visited the local hospital emergency unit, where she received a tube of Maxitrol ointment (antibiotic steroid combination) and instructions to make an appointment with an eye care practitioner as soon as possible. She arrived at our office

on the following Monday morning (two days after the injury occurred) with a lot of pain and desperate for help. Her eye was hyperaemic, and she had lost more than 60% of the corneal epithelium, as well as a large chunk of the conjunctival epithelium in the 7h00 to 8h00 bulbar area (Figure 124). Visual acuity was 6/60- and she was not quite lucid after taking several self-prescribed pain killers. IOP was measured with the rebound tonometer at 15 mmHg in both eyes. Case history revealed that the cleaner contained a 5% solution of ammonium hydroxide, an alkaline solution. A diagnosis of a grade 1 alkaline burn was made. In grade 1 burns the injury is usually confined to the corneal and conjunctival epithelium, the cornea is clear and there is no limbal ischaemia. Visual prognosis is therefore excellent. Treatment consisted of copious irrigation with normal saline for 30–45 minutes to normalise the pH, the fornixes were swept, cyclopegic drops were instilled, a soft bandage lens (Acuvue Oaysys®) inserted to promote epithelial healing and minimise pain, and a topical fluoroquinolone antibiotic drop prescribed q2h. The patient was seen daily to monitor the condition and to replace the lens [398]. The sequence of photographs shows the eye at initial presentation, two days later, six days later, and at complete resolution of the injury (Figures 124–127).

Ammonium hydroxide results in a corrosive injury to the mucous membranes of the eye, due to the alkaline pH and the hygroscopic nature of ammonia. Alkali chemicals are lipophilic and penetrate cell membranes, including those of the cornea readily through saponification of membrane lipids [576]. Hydroxyl ions, which are common to many alkaline chemicals, denature the collagen matrix of the cornea, which further facilitate chemical penetration [577]. Potent alkalis can reach the anterior chamber within 15 seconds damaging structures, such as the trabecular meshwork, lens and ciliary body [577]. Affected tissues may undergo liquefaction necrosis, in which the inflammation triggers the release of proteolytic enzymes, leading to a cascade of damage [576]. Chemical damage to the conjunctiva can lead to scarring, symblepharon, cicatrical ectropion or entropion and destruction of the limbal stem cells, which leads to neovascularisation and opacification of the cornea [577]. Glaucoma can arise from damage to the trabecular meshwork and damage to the structures of the anterior segment [576, 577]. The classification of the injury depends on the extent of conjunctival, corneal and limbal ischaemic damage [576, 577]. The degree of limbal ischaemia (blanching) must be carefully investigated and fluorescein should be instilled, to determine the extent of corneal and conjunctival damage [576]. The major treatment goals that are important throughout the healing phases are: re-establishment and maintenance of an intact and healthy corneal epithelium, control of the balance between collagen synthesis and collagenolysis, and minimising the adverse sequelae that often follow a chemical injury. Acute phase treatment includes, a broad spectrum topical antibiotic, cycloplegic and antiglaucoma therapy [576].

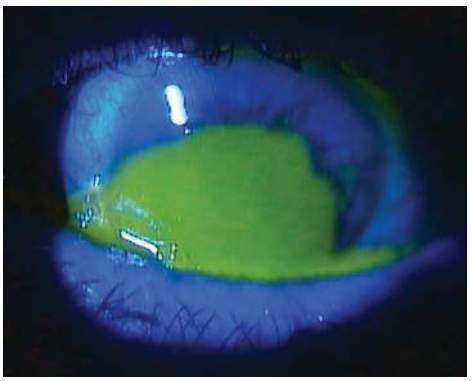

Figure 124: Epithelial cell loss due to chemical injury on presentation

Figure 125: Day two after treatment commenced

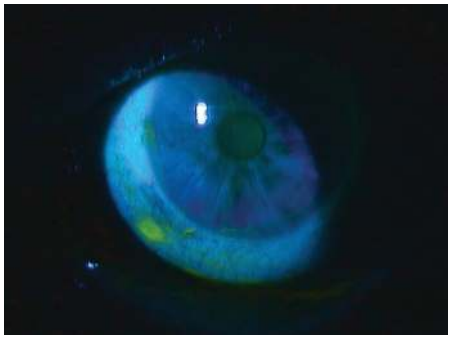

Figure 126: Six days after treatment commenced

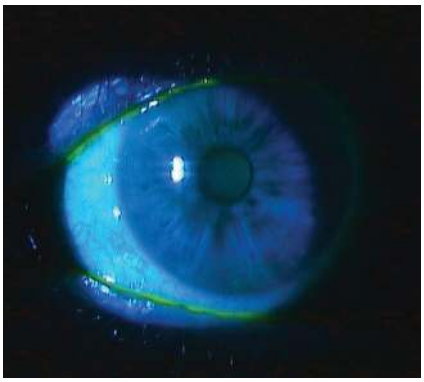

Figure 127: Resolution

THERAPEUTIC LENSES AS DRUG DELIVERY SYSTEMS

Although therapeutic contact lenses have been used for many years to treat corneal injuries, post surgically and in keratoconjunctivitis sicca, their use as drug delivery systems to the diseased eye is in its infancy. The ocular surface is readily available for the administration of drugs making the preferred routine to treat ocular disorders. However, the use of eye drops as a dosage form suffer from some major limitations. These limitations include the short residence time in the cornea, due to its rapid clearance and dilution by the tears, and the fact that most of the drug is drained through the nasolacrimal ducts leading to unwanted systemic absorption and adverse effects [578]. Consequently, topical drugs have a low bioavailability (<5%) and reduced residence time in the tear film (<3 minutes) [579, 580]. This necessitates frequent high doses to achieve therapeutic levels in the eye. The stance of Stone et al., 2009 is that the lack of manual dexterity in the geriatric population and non-compliance with eye drop treatment regimens are two major limitations in eye drop administration [581].

To overcome the limitations of eye drops as a dosage form, various strategies have been employed, which include permeation enhancers, viscous and adhesive polymers, collagen shields, nanoparticles, colloidal carriers, ocular implants and contact lenses [582]. Several studies have demonstrated that contact lenses can be used as drug delivery systems for the treatment of chronic and acute eye disease [583–585]. Therapeutic contact lenses consist of pHEMA with or without silicone, which are impregnated with drugs through various techniques, such as soaking in a drug solution, colloidal particle laden lenses, molecular imprinting and micro-emulsion gels [582]. The drugs diffuse into the post-lens tear film and then into the cornea leading to increased retention of the drug on the surface of the cornea, increased bioavailability, increased therapeutic efficacy and a reduction in the amount of drugs administered, as well as preservatives used [582]. Although commercially available contact lenses soaked in a drug solution are the most simplistic, it has many limitations including poor uptake or release of the drug, poor retention of the drug within the lens, and therefore lack of sustained delivery to the eye [582]. Of concern is that these authors draw attention to the fact that no studies showed prolonged drug release exceeding two hours [582].

Modified medicated contact lenses use a barrier to prevent molecular diffusion of the drug from the lens matrix prolonging its action. Creation of these barriers can affect lens transparency, as well as oxygen permeability. One way to create a barrier is to soak the lenses in vitamin E, before drug incorporation [586]. Lotrafilcon A (Focus Night & Day) contact lenses are especially suited for this type of drug delivery system [586]. Depending on the concentration of the vitamin E, the release time can be manipulated from 5.5 to 192 hours for 16% and 74% vitamin E respectively [582]. Imprinted medicated contact lenses, involve the formation of macromolecular memory sites during the contact lenses polymerisation process to accommodate the drug. The degree of polymer crosslinking plays an important role in the stability of the imprinted cavities. However, high polymer crosslinking affects the hydrogel's transparency, optical performance, flexibility and water content making the lenses unsuitable for ocular use [582].

Additional strategies to overcome the limitations of eye drops as a dosage form, involve the use of nanoparticles and their ability to include several drugs and control their release within the contact lenses [582]. The nanoparticles are incorporated during the production of the lens ensuring a high concentration in the lens matrix, and therefore drug loading capacity [587]. Drug release is affected by the specific nanoparticles used and in the case of polymeric nanoparticles the release of timolol can be sustained for two to four weeks in a temperature dependent manner [588].