Dry eye

Part 4 – Tear retention

In the last of our series looking at dry eye and its management, **Jim Farrell** describes some of the methods of maintaining the tears upon the ocular surface. CET Module C14261, one general CET point, suitable for optometrists and dispensing opticians, one specialist point for CLOs

Part 3 in this series described ways of supplementing a poor or dysfunctional tear film. This concluding part discusses ways of maintaining the reduced tear film within the eye to prolong its usefulness and thereby help towards dry eye therapy.

TEAR RETENTION

While tear fluid supplements provide some relief from symptoms and are a convenient form of therapy,[1] they may not be sufficient in severe cases of KCS. Patients who do not respond to topical medication require more aggressive therapy, and the most satisfactory regimen of therapy may best be achieved by the preservation of existing tears. This can be achieved through sealing the natural drainage channels that lead the tears to the nasal meatus. It has been suggested that 70 per cent of the pre-ocular tear volume drains via this route,[2] the remainder being lost to evaporation and conjunctival absorption. Punctal occlusion evidently has the potential to conserve the volume of tears that normally drain through the lacrimal puncta, and the change may be observed as a physical increase in the height of the tear menisci.

The concept of a punctal plug was first introduced in 1975 as a non-surgical, readily reversible means of occlusion.[3] In the clinical environment punctal occlusion may be achieved with either temporary or permanent plugs. Temporary punctal occlusion with dissolvable collagen implants is a simple and painless approach to tear preservation. The insertion procedure is generally straightforward, and the blockage lasts approximately four to seven days.[4] If a temporary occlusion eliminates most of the patient symptoms, then a more permanent silicone plug can be considered. In the USA the puncta are commonly occluded, with both collagen and silicone materials, as a treatment for dry eye and also to manage secondary dry eye associated with contact lens wear.[5-11] Occlusion generally improves patient symptoms,[5-6,8,10] presumably by maintaining the depleted ocular fluid on the pre-ocular surface. The reported complications that may result from punctal occlusion include mild irritation, epiphora, infection of the canaliculi, and re-patency.[12-14]

Figure 1 Collagen implants are inserted using jewellers' forceps

Collagen and silicone are biocompatible materials that are commonly used within the medical profession for surgical procedures and artificial implants. The use of these materials for punctal plugs ensures a desirable physiological response, and removes the risks of immunological rejection, toxicity, and infection.

Properties of collagen implants

Collagen is a group term for a small range of fibrous proteins that occur in vertebrates as the principal constituent of connective tissue. On prolonged boiling with water it yields gelatin; a colourless, transparent and odourless material in purified form. Gelatin has the property to dissolve slowly in hot water, but when placed in cold water it swells considerably to produce an elastic, transparent mass. It is used successfully in medicine for temporary sutures, surgical dressings, and as a coating for drug capsules. The material's potential to swell and dissolve makes it ideal for use in the manufacture of temporary punctal implants. The manufacturers of dissolvable collagen implants claim the implant will dissolve *in vivo* after four to seven days. The biological polymers used to produce collagen implants are believed to originate from either porcine or bovine sources.

Collagen implants are available in diameters from 0.2mm to 0.6mm in 0.1mm steps, and lengths of 2.0mm and 1.6mm. In the normal eye the diameter of the puncta is approximately 0.5mm[15] with the canaliculi having smaller diameters. Selection of the 0.3mm collagen implant is recommended as first choice for canalicular occlusion. The small diameter plugs are mainly for paediatric use while the larger ones are designed for subjects with unusually large puncta. The most commonly used sizes are the 0.3mm and 0.4mm diameters with a standard length of 2.0mm.

Procedure of insertion

Dilation of the punctum is optional and, when undertaken, care must be given to obviate the risk of weakening the punctum muscle fibres, however the area is generally anaesthetised by instilling one drop of benoxinate hydrochloride (0.4 per cent) into the lower conjunctival sac several minutes prior to commencing the insertion procedure. Collagen implants are inserted into the puncta using jewellers' forceps (Figure 1) under slit-lamp biomicroscopic magnification. The largest possible diameter implant should always be used to ensure the plug is lodged in the horizontal portion of the canaliculus.

- All forceps and holders must be cleaned and disinfected before use
- The biomicroscope eyepieces are correctly adjusted for the interpupillary distance of the clinician, and focused at X25 magnification using the ▶

manufacturers supplied focusing rod
- The subject is seated comfortably at the instrument, with their chin placed securely in the chin rest, and forehead firmly against the headrest
- The instrument is correctly lined up to ensure that the subject's eye is central and level with the chin adjusting hash marks
- The subject is then instructed to look up while the lower eyelid is gently pulled down and away from the globe to reveal the lower punctum (Figure 2)
- The bottom half of the implant is then placed into the punctum and the forceps released
- The lower eyelid is then pulled temporally with the fingers to straighten out the angle between the vertical and horizontal canaliculi
- The blunt tip of a Langs' dilator (No1), or equivalent, is then used to gently push the top of the implant down into the canaliculus below the level of the punctum
- The Langs' dilator is then removed and the eyelid released
- If required a similar procedure is then repeated for the ipsilateral superior punctum and/or the contralateral eye.

After insertion the force of the eyelid blink will cause the implant to migrate further into the horizontal canaliculus where it will lodge prior to the common canaliculus. After absorbing some of the existing tears the collagen implant will swell to approximately twice its original diameter. When properly inserted the implants will not fall out of the puncta or irritate the ocular surface at any time, and the subject should therefore not experience any discomfort from the implants. However, loss of collagen implants, through migration into the nasal meatus, may sometimes occur and in this case re-occlusion with a larger diameter implant is recommended.

Properties of silicone plugs

Silicone is a synthetic material derived from mixed organic-inorganic silicon compounds. Silicone elastomers have the property to be soft and flexible. In addition they are non-toxic, hydrophobic, insoluble, and resistant to bacterial colonisation. These properties render the material ideal for specialised use in prosthetic devices, contact lenses, and medical implants including non-dissolvable punctal plugs. The basic process used for the manufacture of punctal plugs involves moulding, as silicone elastomers are amorphous in their raw state.

Silicone plugs are commercially available in a wide range of designs,

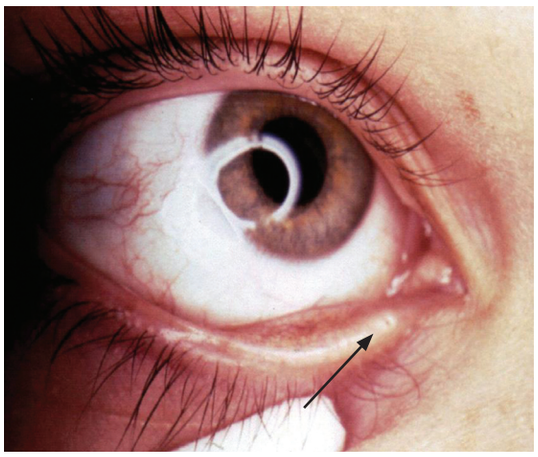

Figure 2 Lower eyelid punctum

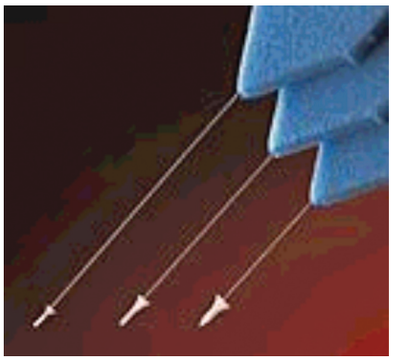

Figure 3 Plugs with pre-mounted stylets

and may be classified as either intracanalicular plugs or punctal plugs.

Intracanalicular plugs are designed to sit beneath the punctal ring and to lodge themselves in the horizontal canaliculus. In the event of prolonged epiphora etc they can be removed by gently irrigating the nasolacrimal system.

Recent types of intracanalicular plug include the SmartPLUG which is made of a thermosensitive material that, when inserted and warmed to body temperature, becomes a soft and cohesive gel which conforms exactly to the punctum shape.

Punctum plugs are designed with a tapered shaft that rests beneath the punctum but have a thin flat rim that prevents the plug from migrating into the canaliculus. The rim lies flat on the eyelid, which allows the clinician to remove them easily with the use of small forceps without the need for irrigation. Occasionally patients may complain of mild irritation if the rim rubs on the bulbar conjunctiva, and this may suggest an incorrect fitting diameter as first choice. Fitting gauges are available from the suppliers to aid the clinician with selection of the most appropriate punctum plug diameter.

In view of the wide choice of silicone designs available, the reader is advised to contact the various manufacturers directly for further information on the range of sizes and suggested fitting protocol for their designs. However, the details of two common designs will be discussed further here, namely Herrick lacrimal plugs and FlexPlugs.

1) Herrick lacrimal plug (Intracanalicular)

The plug is funnel-shaped with a fixed diameter in the cylindrical shaft, and a variable diameter collapsible bell in the funnel end for securing the plug in position within the horizontal canaliculus. These plugs are currently available in three shaft diameters of 0.3mm, 0.5mm and 0.7mm. The small diameter plug is mainly for paediatric use and for patients with unusually small puncta. The more commonly used size is the 0.5mm shaft diameter, which has a collapsible bell diameter of 1.4mm.

Procedure of insertion

Herrick lacrimal plugs are inserted into the puncta, from the pre-mounted wire stylet supplied with the plugs (Figure 3), under slit-lamp biomicroscopic magnification. As with collagen implants the largest possible diameter implant is always used to ensure the plug lodges securely in the horizontal portion of the canaliculus.

- The slit-lamp biomicroscope and patient are set up as described in steps 2-5 for collagen implants
- Moisten the plug with saline or artificial tears to ease insertion
- The tapered shaft of the plug is then placed into the punctum and vertical canaliculus until the collapsible bell rests on the punctum
- The top of the insertion stylet is then rotated temporally until almost parallel with the eyelid margin in order to straighten out the angle between the vertical and horizontal canaliculi
- The plug is then advanced several millimetres into the horizontal canaliculus until the collapsible bell folds inward and is below the level of the punctum
- After insertion the stylet is rotated and withdrawn, and the eyelid released gently
- A similar procedure is repeated for the contralateral eye.

After insertion beneath the punctum the bell-end of the plug reopens to regain its original shape. The force of the eyelid blink will cause the plug to migrate further into the horizontal canaliculus

where it will lodge and remain prior to the common canaliculus.

2) FlexPlug (Punctal)

This plug is supplied pre-loaded on a disposable inserter, which makes insertion relatively easy for the clinician. The design has a flattened rim that remains outside the punctum, and a central tapered shaft that is ribbed (Figure 4) to create a vector force which retains the plug tight in the punctal opening. The plug is available in diameters of 0.5mm, 0.6mm, 0.7mm and 0.8mm. In general, optometrists prefer using punctum plugs to intracanalicular plugs, for both temporary and permanent occlusion, because of their visibility on the eyelid margin and relative ease of removal.

Procedure of insertion

FlexPlugs are inserted under slit-lamp biomicroscope observation, and released from the pre-loaded inserter when the release button is pressed.

- Set up the slit-lamp and patient as previously described for collagen inserts to reveal the punctum
- Use a sterile gauging system to identify the correct plug diameter for use with the patient (available from the punctal plug supplier)
- Moisten the selected plug with saline to ease insertion
- Hold the inserter like a pencil
- Gently insert the plug using a rotational motion
- When the plug is correctly positioned in the punctum, depress the release button on the inserter
- Remove the disposable inserter away from the plug while keeping the button depressed
- Repeat the procedure for the contralateral eye.

Punctal plugs can be used with success, temporarily, in the post-operative management of refractive surgery and may also be of value in managing the symptomatic 'dry eye' contact lens wearer, provided there is no underlying sinister cause.

Figure 4 Ribbed FlexPlug

Punctal occlusion – clinical markers for success

The following points are based on clinical studies undertaken in aqueous deficient dry eye patients attending the Glasgow Royal Infirmary. They may be of value to the clinician when undertaking occlusion follow-up appointments:

- Symptoms should be carefully monitored[16] for both temporary and permanent punctal occlusion treatments in the aqueous deficient dry eye. After occlusion the subjective symptoms should reduce by approximately half.[17] If there is no change in symptoms, then the integrity of occlusion should be confirmed and larger diameter plugs used if required
- Tear stability should be monitored[16] for permanent punctal occlusion treatment in the aqueous deficient dry eye. The median keratometer tear thinning time (TTT) values for normal and aqueous dry eyes are around 17s and 3s respectively.[18] After 6-12 months of occlusion treatment with a permanent silicone plug, inserted into the lower punctum, the TTT value in the dry eye should increase by around five seconds
- Tear volume should be monitored for both temporary and permanent punctal occlusion treatments in the aqueous deficient dry eye. Using a slit-lamp video-biomicroscope system to measure tear meniscus height (TMH), the median values for normal and aqueous dry eyes are around 0.22mm and 0.13mm respectively. After five days of temporary occlusion with collagen implants the TMH value will increase to around 0.20mm.[17,18] This increased TMH will remain level for up to 12 months post-occlusion when treated with permanent silicone plugs. Note that the relative change in TMH, for the measuring method, is more important than the absolute value and is a powerful indicator of occlusion success
- When using collagen implants as a provocative test in the aqueous deficient dry eye to determine long-term occlusion suitability, the lower puncta only can be occluded, provided the follow-up review is conducted not more than five days post-occlusion to assess the symptoms and TMH as clinical markers for success.[19] Otherwise both ipsilateral puncta should be occluded
- When using silicone punctal plugs in the aqueous deficient dry eye for long-term treatment, follow-up appointments are recommended at intervals of six months post-occlusion to assess the symptoms, TTT, TMH and epithelial staining as clinical markers for success.[16]

Environmental therapeutics for the dry eye patient

The effects of a change in environmental conditions, temperature, humidity, and season on the dry eye are well known.[19] Therapeutic advice is often given to minimise identifiable risk factors such as smoking and caffeine[20] and to help alleviate aggravated

symptoms. Warm temperatures and low humidity environments are poorly tolerated.[21] Moist chamber goggles,[22] mobile infusion pumps,[23] and room humidifiers are several options available to improve the humidity around the pre-ocular surface. A relative humidity of 40 to 50 per cent would be ideal for the tear film.[24] Improvements in dry eye syndrome with these methods are extremely subjective and heavily based on individual patient reports. However, anything that may help the patient tolerate this debilitating condition should actively be pursued, including 'blink exercises'. A new product aimed at enhancing local humidity has recently been launched and will be reviewed in *Optician* in a few weeks.

In conclusion, optometrists are well placed to clinically assess and manage dry eye conditions arising from both primary and secondary causes, including contact lens wear. In the interests of continuing patient care the clinician should work in partnership with other health professionals to ensure the delivery of a high quality eye care service. In this way the most appropriate treatment mode will always be adopted to effectively meet the patient needs.

MULTIPLE-CHOICE QUESTIONS – take part at opticianonline.net

1 The reported *in vivo* decay time for collagen implants is?
A 2 to 4 days
B 3 to 5 days
C 4 to 7 days
D 5 to 7 days

2 After absorbing some existing tears, a collagen implant will swell and increase its diameter by?
A Approx 0.5 times its original
B Approx 1.5 times its original
C Approx 2.0 times its original
D Approx 2.5 times its original

3 Which one of the following statements is true regarding the FlexPlug?
A They are made from collagen material
B The rim of the plug sits flat on the eyelid surface
C They are intracanalicular
D They are removed by irrigating the nasolacrimal system

4 Which one of the following statements is true regarding the Herrick lacrimal plug?
A The most commonly used size is the 0.3mm diameter
B The 0.5mm diameter plug is mainly for paediatric use
C They are removed with jeweller's forceps
D They are an example of an intacanalicular design

5 As a clinical marker of success, which one of the following statements is true regarding the TMH?
A The relative change in TMH is a powerful indicator of occlusion success
B TMH measurement has no value in the clinical assessment of punctal occlusion
C The reported pre-occlusion median value in aqueous dry eyes is 0.20mm
D The TMH will only increase after 12 months of occlusion

6 The reported ideal humidity level for the tear film is between?
A 10 per cent and 20 per cent
B 20 per cent and 30 per cent
C 30 per cent and 40 per cent
D 40 per cent and 50 per cent

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.
The deadline for responses is August 12 2010

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