Detection & Management of Dry Eye

Dr Simon Barnard
PhD BSc FCOptom FAAO DCLP DipClinOptom

East Yorkshire & North Lincolnshire

LOC

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To Treat or not to treat….

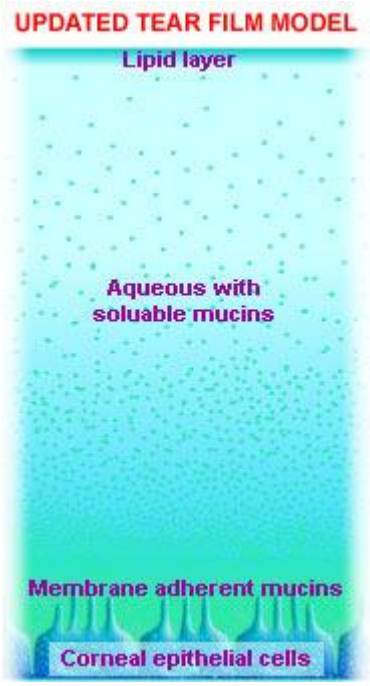
Dry eye is commonly diagnosed in primary care practice. Management strategies depend on a number of factors including the

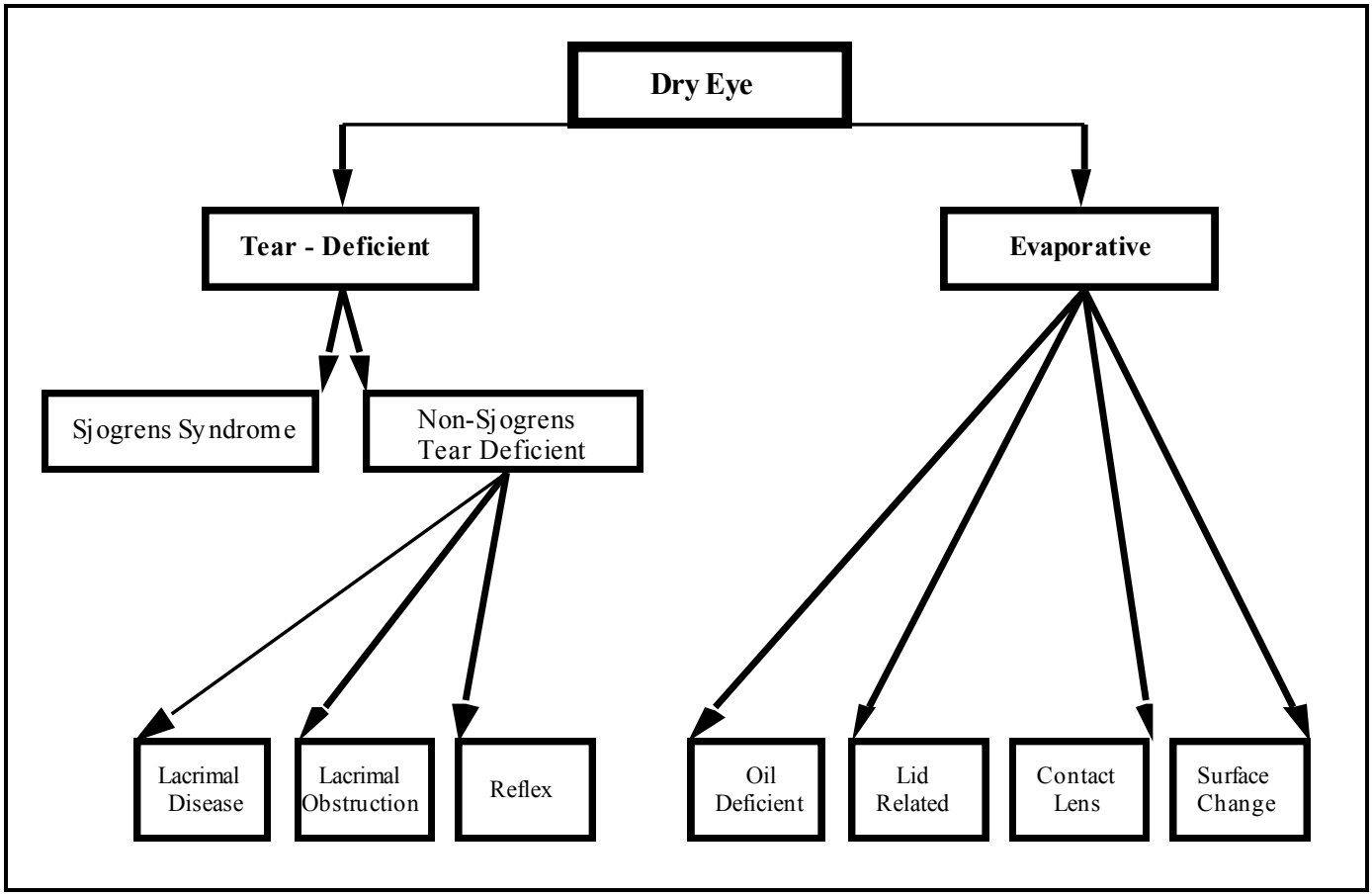
- The type/cause of “dry eye”
- Severity and effect of the dryness
- The patient response to symptoms

BACKGROUND:

Tear film layers: functions

- **Lipid** - retards evaporation of the aqueous layer, prevents overflow onto the lids and prevents contamination of the tear film by skin lipids.
- **Aqueous -** provides a smooth optical refracting surface, contains nutrients from the bloodstream, allows the diffusion of oxygen from the atmosphere to the avascular cornea and contains anti-bacterial agents for ocular defence.
- **Mucous** - provides stability for the overlying tear film and lubrication for lid movement over the epithelial surfaces, traps debris and conveys it towards the caruncle for elimination, and provides a reservoir for immunoglobulins.





Dry eye

The term “dry eye” describes a condition which is characterised symptomatically by the sensations of “burning”, “itching”, and “grittiness” and clinically by desiccation of the ocular surface, irrespective of the aetiology. In 1995, Lemp classified the condition into “aqueous deficient” and “evaporative” dry eye.

Symptomatology

Clinical assessment of the tear film must include a thorough history and symptom taking. A standardised questionnaire can help to make symptomatic evaluation more consistent between patient visits and between different clinicians. Several questionnaires have been developed for this purpose, but the one most commonly used in the field is that designed by McMonnies in 1986. This is shown below, complete with a marking schedule which can help predict the presence of dry eye or monitor the effects of therapy.

Please answer the following by underlining the responses most appropriate to you:
female / male. Age: less than 25 years^{0} / 25 - 45 years$^{(M1/F3)}$ / more than 45 years$^{(M2/F6)}$. Currently wearing: no contact lenses / hard contact lenses / soft contact lenses.

1. Have you ever had drops prescribed or other treatment for dry eyes? Yes^{6} / No^{0} / Uncertain^{0}
2. Do you ever experience any of the following eye symptoms? (Please *underline* those that apply to you.) 1. Soreness 2. Scratchiness 3. Dryness 4. Grittiness 5. Burning
3. How often do your eyes have these symptoms? (*underline*) Never^{0} / Sometimes^{1} / Often^{4} / Constantly^{8}
4. Are your eyes *unusually* sensitive to cigarette smoke, smog, air conditioning, or central heating? Yes^{4} / No^{0} / Sometimes^{2}
5. Do your eyes become very red and irritated when swimming? Not applicable^{0} / Yes^{2} / No^{0} / Sometimes^{1}
6. Are your eyes dry and irritated the day after drinking alcohol? Not applicable^{0} / Yes^{4} / No^{0} / Sometimes^{2}
7. Do you take (please *underline*) antihistamine tablets^{2} or use antihistamine eye drops^{2}, diuretics^{2} (fluid tablets), sleeping tablets^{1}, tranquillisers^{1}, oral contraceptives^{1}, medication for duodenal ulcer^{1}, digestive problems^{1}, high blood pressure^{1}, antidepressants^{1} or ...? (Write in any medication you are taking that is not listed.)
8. Do you suffer from arthritis? Yes^{2} / No^{0} / Uncertain^{0}
9. Do you experience dryness of the nose, mouth, throat, chest or vagina? Never^{0} / Sometimes^{1} / Often^{2} / Constantly^{4}
10. Do you suffer from thyroid abnormality? Yes^{2} / No^{0} / Uncertain^{0}
11. Are you known to sleep with your eyes partly open? Yes^{2} / No^{0} / Sometimes^{1}
12. Do you have eye irritation as you wake from sleep? Yes^{2} / No^{0} / Sometimes^{1}

Scores: Normal (< 10) Marginal dry eye (10 - 20) Pathological dry eye (>20)

AETIOLOGY

Dry eye can result from deficiencies of the tear film, the eyelids or the ocular surface. Examples are listed below.

Tear film abnormalities	Lid surfacing abnormalities	Ocular surface disorders
Lipid deficiency (e.g. MGD)	Symblepharon	Irregularity (e.g., LIPCOF)
Aqueous deficiency (e.g. KCS)	Scarring (trauma / trachoma)	Scarring (e.g. trauma)
Mucous deficiency	Incomplete blinking (e.g. C/L	Epitheliopathy

It is therefore important to observe and quantify the tear physiology to determine the aetiology of the dry eye and, ultimately, advise the optimum treatment. In general, tear evaluation techniques which irritate the corneal or conjunctival surface will cause reflex tearing and affect the parameter under investigation. They should therefore be avoided wherever possible, (i.e. where a less invasive test is available).

CLINICAL ASSESSMENT OF THE DRY EYE

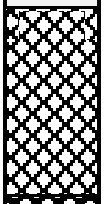
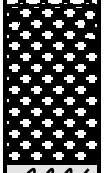
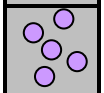
Slit-lamp biomicroscope

Routine examination with a biomicroscope can provide invaluable information, non-invasively, about various aspects of the tear film and epithelial surfaces.

These will be dealt with in turn:

Eyelids	Examine the lid margins and lashes for abnormality. Look for signs of blepharitis. Study the gland orifices and examine the meibomian glands (evert lids: translucent = normal, yellowish outline indicates blockage). Transilluminate if possible. Look for age-related changes. Express the meibomian glands to determine any dysfunction. Fluid should be transparent and flow easily. Cloudy expression = slight dysfunction; expression of toothpaste-like consistency = moderate dysfunction; inexpressible (no expression) = severe dysfunction.
Blinking	Study the pattern of blinking. Look for incomplete blinks or reduced blink rate. Remember patient awareness of test may affect blinking!
Cornea	Use slit-lamp beam to check for regularity and quality of the surface with a thin optical section. The placido disc attachment for the Tearscope Plus™ gives indication of corneal topographical regularity. Use vital stains to assess damaged / devitalised areas. Fluorescein will stain areas of epithelial cell loss. Grading scales can improve repeatability of assessments. Consider sequential staining to increase sensitivity. Rose bengal (irritating) stains primarily dead and devitalised cells and mucus. Grade rose bengal staining over three areas, divided vertically at the limbal edges, as 0 (none), 1 (mild), 2 (moderate) or 3 (severe). Sum values for a score out of 9. Scores >3.5 indicate dry eye.

Conjunctiva	Assess conjunctival hyperaemia with a standardised scale (e.g. McMonnies and Chapman-Davies (> Grade 4 = dry eye), Efron, CCLRU). Look for lid-parallel conjunctival folds (LIPCOF) bordering the posterior lid margin in primary direction of gaze: Grade 0: no folds, Grade 1: single fold less than tear prism height (15 x more likely to have dry eye than individual with grade 0), Grade 2: multiple folds up to tear prism height (63 x more likely), Grade 3: multiple folds higher than tear prism (190 x more likely). Impression cytology allows a more quantitative assessment of conjunctival health. Cells, collected from the bulbar conjunctiva on cellulose acetate sheets, are stained to show goblet cell density and epithelial cell morphology (↓ goblet cell count in dry eye results in ↓ tear film mucous).
Interference phenomena.	Visible by specular reflection over a small area with a slit-lamp only when thickness >100 nm. Be aware of drying effects of slit-lamp beam. Tearscope Plus™ uses wide-field, cold light source, allowing observation of lipid layer by interferometry. Layers less than 100 nm thick show no colour. Typical patterns observed are described below.

Pattern	Appearance		Estimated thickness (nm)
Absent		No pattern visible.	0
Marmoreal: Open meshwork		Indistinct, grey marble-like pattern (usually visible only by post-blink movement), appears slightly thicker when the palpebral aperture is narrowed.	10 - 20
Marmoreal: Closed meshwork		Well-defined grey, marble-like pattern with a tight meshwork. Often described as looking like a knitted jersey, or like fish scales.	20 - 40
Flow		Constantly changing wave-like pattern.	30 - 90
Amorphous		No discernible features on an even background. May show some coloured fringes when the palpebral aperture is narrowed.	80 - 90
Coloured fringes: normal		Coloured interference fringes of the first order of interference (mainly blues and browns).	>100
Coloured fringes: abnormal / globular		Discrete areas of highly variable coloured fringes of the second or third order of interference.	Variable

Interference phenomena (cont'd)	Thinner and abnormal lipid layers are associated with poor tear film stability but only non-confluent or absent patterns are unable to inhibit evaporation of the underlying aqueous layer. Lipid layer abnormalities can arise from blocked meibomian glands, poor apposition of lid margin to the globe, blepharitis or poor lipid quality (composition). Any contamination of the lipid by make-up or skin lotions should be noted.
Tear meniscus	Examine the regularity and height of the tear reservoir. Heights of less than 0.2 - 0.3 mm indicate aqueous insufficiency. Irregular menisci with scalloped edges are suggestive of dry eye. Watch slit-lamp beam does not dry tear fluid. Tearscope Plus™ - allows observation of full meniscus length with cold light - observe "sandwich" (black line) centrally for width and regularity (can highlight blocked meibomian glands).
Particulate matter	Often consists of mucous strands and cellular debris in KCS. Movement of particles can give indirect assessment of tear film viscosity (slow = high viscosity, fast = low viscosity).
Tear film stability	Gives important information about tear film integrity and function. Traditionally measured with fluorescein in tear film and cobalt-blue filter on slit-lamp. Observe the tear film for dark spots (indicating break-up) following a blink. A value of less than 10 seconds is borderline, less than 5 seconds is indicative of dry eye. However, fluorescein, in these concentrations, destabilises the tears, giving poor results. Non-invasive techniques which do not involve contact with the ocular surface are superior. Such techniques include the HIRCAL grid (not commercially available), keratometer mires (B&L), the Loveridge grid (hand-held) or the Tearscope Plus™ (with or without grid attachment). Grid pattern or keratometer mires are reflected from tear film surface. The time between a blink and the first appearance of a distortion in the mire pattern indicates the non-invasive break-up time (NIBUT) or tear thinning time (TTT). Values of less than 20 seconds are borderline while those less than 10 seconds are indicative of dry eye. A mean of at least 5 measurements should be taken.

Tear production	Evaluates lacrimal gland function. Traditionally, the Schirmer test has been used. However the irritation caused by the insertion of a filter paper strip, at the temporal side of the lower lid, is significant and causes reflex tearing. Values of less than 5 mm of wetting in 5 minutes signifies a pathological dry eye; between 5 and 10 mm, a borderline dry eye; and more than 10 mm, normal.

Tear production (continued)	The Phenol Red Thread (PRT) Test is significantly less invasive than the Schirmer test. The cotton thread impregnated with dye changes colour (from yellow to red) in the presence of the alkaline tear film. The tip of the thread is placed in the inferior temporal fornix and a measured wetted length of less than 10 mm in the 15 second measurement period is suggestive of deficient tear production. Dilution tests have also been used to give an indication of tear flow. Rose bengal and fluorescein are instilled into the lower fornix and the degree of dilution observed after 5 minutes (yellow meniscus = healthy, red meniscus = poor turnover). For more quantitative results, colour can be compared to prepared dilution standards. The tear function index (TFI) combines the assessment of both tear secretion and tear drainage. The TFI is the Schirmer test value (in mm) divided by the tear clearance rate (dilution as a fraction). Less than 96 suggests the presence of dry eye.
Tear quality	Alterations in tear quality are reflected in the drying patterns of tear samples. Tear fluid is placed on a glass slide to dry and the resulting patterns are viewed under white-light microscopy (tear ferning). The tears of dry eyes produce less-pronounced crystallisation than those of healthy eyes.

CONCLUSION

Careful attention must be paid to the order in which tear film tests are carried out. The non-invasive tests (e.g. non-invasive tear film stability, interference phenomena, meniscus assessment) should be performed first, followed by the minimally invasive tests (e.g. phenol red thread, tear ferning) and finish with the

most invasive tests (e.g. ocular surface staining, impression cytology, meibomian gland expression).

It should be remembered that the result of a single parameter is not sufficiently sensitive or specific upon which to base a diagnosis of dry eye. The best assessment of lacrimal system status will be obtained when the results of several tests are considered. Most of the tests highlighted here are simple and relatively quick to perform. As such, a selection should be chosen to form part of a routine anterior segment assessment, particularly where dry eye is suspected or where the patient is a prospective or existing contact lens wearer.

Lipid deficiency

Lipid deficiencies are commonly associated with

- blepharitis and/or meibonitis
- acne rosacea
- contact lens wear

The practitioner will therefore manage the underlying cause(s). For example in the case of an associated acne rosacea, the optometrist should liase with the GP concerning recommended oral antibiosis.

Mucin deficiency

Mucin deficiency are probably less prevalent than serous and lipid deficiencies. Any known underlying cause, e.g., hypovitaminosis A, should be treated.

Aqueous deficiency

Keratoconjunctivitis sicca is commonly seen in primary care practice. There are many possible causes. Primary Sjögren syndrome is characterised by KCS, dry mouth and arthralgia. Previous medical diagnosis is important as secondary Sjögren' syndrome is associated with disease of liver, thyroid, spleen and kidney.

Aqueous deficiency may be drug induced e.g., antihistamines, antimuscarinics, beta-blockers, diuretics.

Management strategies

Dry eye may be managed in a number of ways depending on the cause(s):

- Lid hygiene
- Tear replacement and ocular lubrication
- Drug treatment
- Tear preservation
- Surgery
- Contact lenses

Lid hygiene

One of the commonest conditions seen by optometrists in primary care practice is bacterial blepharitis. *Staphylococcus aureus* is strongly associated with blepharitis and meibomian gland dysfunction. The organism produces exotoxins some of which cause disruption to tear film, inflammatory responses to conjunctiva and cornea, and blockages of the meibomian glands.

Treatment

Extent of optometric intervention depends on severity.

- Commence with very warm compresses and lid scrubs bid. The latter may be carried out with J & J shampoo (10% solution) and a Q-tip or with Lid Care (CIBA).
- Topical antibiotic eye ointment or combination steroid/antibiotic eye ointment
- 6 week course of oral oxytetracycline 250 mg qid then tapering dose over next two weeks.

Meibomian gland expression

Anaesthetise conjunctiva, place saline moistened Q-tip against palpebral conjunctiva. Use another Q-tip or thumb to squeeze lid and express thick meibum. Best results after warm compresses.

Demonstrate and explain ongoing lid care to patient.

Tear replacement

Artificial tears and ocular lubricants

These preparations are designed to give:

- short term relief from symptoms
- prophylactic effect to reduce risk of epithelial desiccation
- therapeutic effect to aid reversal of epithelial damage

Characteristics of artificial tears

Artificial tears are
- isotonic or slightly hypertonic pH
- generally slightly acidic and of a similar viscosity to the tear film
- tonicity and pH are achieved with salts and buffers whilst the viscosity is obtained with polymers such as PVA

Characteristics of ocular lubricants

- all artificial tears provide some lubrication
- lubricants contain higher concentrations of polymers (to increase viscosity), oils or petrolatum

Ingredients

The ingredients of a preparation depend on the desired effect. Lubricants and artificial tears may be categorised by their actions:

- Wetters
- Spreaders
- Breakers
- Washers

Examples include: -

Hypromellose: a cellulose polymer commonly prescribed for serous deficiencies.

Sodium hyaluronate

Polyvinyl alcohol (PVA), polyethylene glycol, Polyacrylic acid and dextran which are all viscosity or wetting agents that assist even and efficient spread of the serous layer of the tears over the corneal and conjunctival epithelium in cases of mucus layer deficiency.

Viscous gels e.g., GelTears, Viscotears, Lacrilube, TheraTears Liquid Gel

Combination gel and lubricant **e.g.,** Systane (Alcon)

Acetylcysteine which is used to break down mucus molecules and is used when excess mucous present. (Messner & Leibowitz, 1971).

Saline eye drops may be used for ocular irrigation and in the presence of meibomian gland dysfunction

Prescribing artificial tears and lubricants

The occasional use of artificial tear or eye-wash should be advocated to reduce symptoms caused by dry or polluted atmosphere e.g., Optrex eye-wash. Chronic dry eye sufferers may need a more viscous lubricant and may also use an ointment at night. Prescribe a lubricant as an adjunct in treatment of vernal conjunctivitis

Generally, advocate the patient the use of these preparations as frequently as necessary be aware of hypersensitivity reactions to preservatives and other constituents e.g., lanolin. Single dose preparations avoid these possible sequelae.

Vitamins and essential fatty acids

There is some **anecdotal** evidence of the efficacy of oil of evening primrose in the management of dry eye in Sjögren's syndrome (Campbell & MacEwen, 1982). Oil of Evening Primrose (Efamol) (contains linoleic and gamma linoleic acids).

Rengstorff et al (1988) evaluated 200 patients with various dry-eye and contact lens-related complications. Patients were asked to apply 2 or 3 drops of Vit-A-Drops daily for 30 days. The authors reported subjective improvements in 95% of the patients and improvements in BUT and slit lamp appearance in 48%. Chandra et al (1988) assessed the affect of Vit-A-Drops on 33 dry-eyes of different aetiology. They reported symptomatic improvement in 87.9% of cases and reversal of keratinisation in 24.2 % of cases. Westerhout (1989) describes the use of these drops on a series of 143 dry-eye problem patients who had not responded to previous therapy. He reported that patients' symptoms were reduced in 88% of cases and increased BUT in 72% of cases. Note that none of these studies were double-blind nor offered a control group.

Westerhout (1991) carried out a double blind study on the use of Vitamin A drops and found a subjective improvement in symptoms in 61% of Vitamin A drop patients compared with 15% of patients using an artificial tear.

Drug treatment

- Cyclosporin
- Interferon
- Acetylcysteine
- Oestrogens
- Antibiotics and steroids

Tear preservation & increased humidity

Spectacle side shields with sponge panels are available (Eagle Vision Inc.) and there have been studies on the use of wet gauze eye masks during sleep.

Punctal & canalicular occlusion

Occlusion of the lacrimal drainage system may be carried out using surgery, glues, and various types of "plug".

Surgical techniques

e.g., laser or electrocautery

Occlusion is obtained by surgically scarring the punctal opening. Surprisingly, a percentage of subjects experience a re-opening of the punctum.

Collagen plugs

These are made of bovine collagen, are temporary and are used for prognostic purposes. They swell to twice their original diameter when wet and last for about 4 - 5 days before fully dissolved. Generally, no anaesthetic required. The plugs are available in various diameters from 0.2 to 0.6 mm in 0.1 mm steps and the practitioner chooses the optimum size by inspection of the puncta.

Procedure for collagen insertion

Having discussed the procedure with the patient, inspect the puncta, choose plug size, disinfect forceps, grasp plug and insert fully into inferior punctum. Repeat for superior punctum and other eye as necessary.

Collagen follow up

Review the patient 10 to 14 days later asking about symptom resolution. Any sustained effect may be due to a therapeutic effect in cases of EBMD (Barnard 1996).

Discuss silicone plugs. Decide on type… punctum or intracanalicular.

Silicone punctum plugs

These are "permanent" plugs that are positioned in the punctum. They are visible which may be thought of as an advantage. Some patients are aware of them and they can dislodge.

This type of plug was pioneered by Freeman (Eagle Vision) but similar types are made by various manufacturers:

Eagle Vision	*Freeman plug*
FCI	*Umbrella plug*
Oasis	*Soft Plug™*

Procedure for insertion

- anaesthetise punctum and canaliculus by instilling one drop of Benoxinate hydrochloride 0.4% into eye and also applying an anaesthetic soaked Q-tip to punctum for 30 seconds
- assess optimum size of plug using proprietary gauge
- insert the plug using pre-loaded applicator tool
- consider instilling antibiotic/steroid drop

Silicone plug follow up

Assess patient's symptoms and signs about 7 days later. If indicated, plug other puntum of each eye with *collagen.* Assess effects 7 days later. Plug other punctum with silicone plug.

Assess patient's need for continued use of tear supplements (cease or reduce?) Routinely examine patient annually. Otherwise manage as per contact lens patient i.e., provide home telephone number etc.

Intracanalicular plugs

These silicone plugs are positioned in the canaliculus just distal to the common canaliculus. They are not visible (advantage ?) and are not felt by patient.

Procedure for insertion

- anaesthetise punctum as before
- choose plug size
- remove styrofoam holders
- separate two plugs & shorten applicator
- dilate punctum and canaliculus using punctum dilator
- insert tip of plug into punctum
- advance into canaliculus, rotating applicator temporally and advancing a further 2 mm towards the nose
- retract applicator
- consider antibiosis

Silicone plug follow up

Follow up after 5 to 7 days and assess patient's need for continued use of tear supplements (cease or reduce ?). Routinely examine patient annually.
Manage as per contact lens patient i.e., provide home telephone number etc.

SmartPlug™

Material properties

- Thermodynamic acrylic "smart" polymer
- Rigid solid at or below 32^{o}C
- Soft and flexible elastomer gel at or above 33^{o}C
- White solid at room temperature

SmartPlug™ is designed to conform to patient's punctum shape and size.

The plug softens and changes shape in response to body temperature.

Prior to insertion (room temperature) it is a long slim rigid rod
Length = 10 mm; diameter = 0.4 mm

After insertion (body temperature) it alters becoming a soft, shorter plug
Length = 2 mm; diameter = 1 mm.

Contact lenses

- low water content hydrogels
- scleral lenses
- silicone rubber

Summary

- Dry eye is commonly seen in optometric practice
- Optometrists have an important role to play in preserving these patients' keratoconjunctival integrity and general comfort
- This presentation has reviewed the types of dry eye and a number of different treatment methods through which optometrists can fulfil this role