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Ocular therapeutic case studies
Tear film abnormalities

Patients manifesting abnormalities associated with their lacrimal system are frequently encountered in optometric practice. Indeed, optometrists may be the first eyecare practitioners to whom these patients present. Thus, optometrists have a pivotal role to play in the initial management of such patients.

ABDO has awarded this article 2 CET credits (GD).

The College of Optometrists has awarded this article 2 CET credits. There are 12 MCQs with a pass mark of 60%.

The term 'tear film abnormalities' encompasses both dry and wet eye disorders. Sometimes, the signs and symptoms appear to contradict one another making the distinction between the two somewhat nebulous. For example, one cause of hypersecretion is ocular surface disease (dry eye).

The aim of this article is to give, through a series of case histories, an overview of the various aetiologies of the dry and watering eye, together with the relevant management in each case.

Anatomy
A sine qua non of identifying the cause of the presenting tear film disorder is the firm appreciation of the underlying anatomy and physiology of the lacrimal apparatus and the associated ocular adnexa. It is only possible in this article to provide an overview of the relevant anatomical components. For a more detailed, nuanced account, the reader is referred to one of the excellent texts listed at the end.

The lacrimal drainage system
The lacrimal drainage system is subdivided into the upper and lower drainage systems. The former consists of the puncta and canaliculi, while the nasolacrimal sac and duct contribute to the latter.

Puncta
The puncta sit on top of a smooth elevation (lacrimal papilla) and lie on the medial end of both the upper and lower eyelids with the upper puncta lying more medial than the lower. In the normal eye, they are directed posteriorly.

Canaliculi
The proximal canaliculi are short (approximately 2mm) and widen to form ampullae before bending medially to form the horizontal canaliculus (approximately 8mm in length). In the majority of cases, the horizontal canaliculi merge to form the common canaliculus. The lower canaliculus is usually slightly longer than the upper, reflecting the more lateral position of the lower punctum relative to its upper counterpart. A small mucosal flap (valve of Rosenmuller) separates the common canalicular opening from the nasolacrimal sac and serves to prevent tear reflux.

Nasolacrimal sac
The sac is located in the lacrimal fossa on the internal medial wall. The common canaliculus enters the sac approximately 3.5mm below its apex. The area above this entrance is known as the fundus, whereas the area inferior to the same entrance point is referred to as the body of the sac. The sac is separated from the middle meatus of the nasal cavity via the lacrimal bone and frontal process of the maxilla.

Nasolacrimal duct
The proximal portion of the nasolacrimal duct lies in the lacrimal fossa. From here, it descends laterally forming an intermediate interosseous portion and a distal intermedial portion. It drains into the inferior meatus of the nasal cavity, which is lateral and inferior to the inferior turbinate. The opening of the duct is protected by a mucosal fold, known as the valve of Hasner, whose function is to prevent air and other nasal contents from entering, especially when the nose is blown. Owing to the variable size of this fold, incomplete coverage of the duct opening is not uncommon. Patients who possess functionally sub-optimal valves demonstrate a unique ability to blow air bubbles out through their puncta, as a result of a disproportionately small covering allowing air to travel up through the nasolacrimal duct.

Lacrimal gland
The gland resides in the frontal bone in the anterio-superior, lateral orbit and consists of both orbital and palpebral lobes. The latter may prolapse through a thinned orbital septum with age, thus manifesting as a supero-lateral lid swelling. The accessory glands of Krause and Wolfring are situated in the upper conjunctival fornix and tarsal conjunctiva respectively.

Eyelids
The orbicularis oculi muscle, which is innervated by the facial (VII) nerve, possesses both an orbital portion and a palpebral portion. The latter consists of a pre-tarsal part and a pre-septal part. The insertions of the orbicularis muscle at the medial canthus are known as heads and form the lacrimal area. Although the orbital portion does contribute to this area, its palpebral counterpart represents the most prominent anatomical feature. Moreover, the existence of a palpebral orbicularis is a prerequisite for normal tear drainage (see later). It is worthy of note that the term Horner's muscle is synonymous with the deep heads of the pre-tarsal orbicularis.

Tear physiology
Tear drainage incorporates both passive and active processes. When the subject is not blinking, the tears continue to drain – albeit at a very low rate – due to capillary action and the natural downhill slope of the eyelids. The majority of tear drainage is an active process with the orbicularis muscle playing an integral part in assisting the flow of tears into the lacrimal apparatus. To date, the exact physiological mechanism underlying the tear film kinetics, from the puncta to the inferior meatus in the nose, remains equivocal. Historically, lacrimal surgeons have either supported the Jones or Rosengren-Doane paradigms. Notwithstanding, all of the investigators agree that the route of the tears is through the puncta, canaliculi, nasolacrimal sac and the nasolacrimal duct. The tears flow into the inferior meatus (in the nasal cavity) thence into the naso-pharynx.

The Jones model[1] suggests that with blinking, the superior and deep heads (Horner's muscle) of the orbicularis contract forcing the puncta to move medially, the canaliculi to shorten and compression of the lumen of the canaliculi. In addition, contraction of the deep heads of the pre-septal portion causes the nasolacrimal sac to expand. The resultant negative pressure allows the tears to flow from the common canaliculus into the sac.

On eyelid opening, the canaliculi expand and lengthen and the sac collapses following relaxation of the orbicularis muscles. Positive pressure is now induced, forcing the tears to flow down the nasolacrimal duct into the nose.

The Rosengren-Donate model[2] agrees with its Jones counterpart with regard to the fact that eyelid closure induces compression of the canaliculi with nasal movement of tears into the nasolacrimal sac. However, this model departs from its correlate by suggesting that eyelid closure causes compression of the nasolacrimal sac (positive pressure) with expansion (negative pressure) on opening. This model is supported by Becker[3].

More recently, Thale[4] proposed that contracture of Horner's muscle dilates the upper part of the lacrimal sac in addition to

compressing the lower region of the sac via peristalsis. The author purports that such peristaltic action enables the collagen and elastic fibres which surround the nasolacrimal duct to 'wring out' the sac in a cranial-caudal direction.

Lacrimal gland physiology

Practitioners should be familiar with the trilaminar structure of the tear film, namely from anterior to posterior, the lipid, aqueous and mucin layers. The superficial lipid layer is secreted by the meibomian glands, the intermediate aqueous by the lacrimal glands (in conjunction with the accessory glands of Krause and Wolfring), and the underlying mucin layer by the goblet and non-goblet epithelial cells which reside on the conjunctival surface. The aforementioned ocular adnexa are important in maintaining a stable tear film from a compositional standpoint. However, hydrostatic factors are also essential for the maintenance of a stable tear film and are provided by the actions of the eyelids. Both the meibum lipids and aqueous components are mechanically spread across the ocular surface. Furthermore, such eyelid movements are not only responsible for milking out the meibum secretions from the meibomian glands but also for tear drainage (see earlier).

A prerequisite for maintaining the appropriate hydrostatic and compositional factors is an intact neural system. Afferent fibres from the cornea (ophthalmic division of the trigeminal nerve, V1) synapse in the nucleus of the spinal tract of V. Within the brainstem, secondary axons from this nucleus synapse in the reticular formation. This initiates bilateral contact with the facial nerve (VII) motor nuclei which, in turn, innervate both orbilcularl resulting in eyelid closure.

It is noteworthy that this is the neural mechanism by which meibum is secreted from the meibomian glands via orbicularis contraction. In addition, stimulation of the cornea gives rise to stimulation of the parasympathetic facial nerve fibres via the salivary nucleus through to the greater petrosal nerve. These preganglionic fibres synapse in the pterygopalatine ganglion. From this ganglion, the post-synaptic fibres follow the zygomatic nerve via the lacrimal nerve to the gland itself. Secretion of aqueous from the lacrimal and accessory glands is mediated by the parasympathetic, secretomotor fibres of the facial nerve (VII). The lacrimal gland also receives sympathetic inputs, notably to the smooth muscle surrounding the arterioles. Thus, these fibres have a regulatory effect on the gland's blood supply.

It has been suggested that the normal or basal tear flow is predominantly under sympathetic control by regulating the gland's blood supply, whereas reflex tear secretion is under parasympathetic control as a result of trigeminal nerve stimulation.

The tears have many functions which include:

- Maintain an optically uniform surface
- Lubricate corneal and conjunctival surfaces
- Provide antibacterial protection
- Provide nutrients to the cornea
- Flush debris from the cornea and conjunctival sac

HYPERSECRETION	FUNCTIONAL EPIPHORA	EPIPHORA DUE TO EYELID, PUNCTA AND CONJUNCTIVA	EPIPHORA DUE TO CANALICULI, SAC AND DUCT	NASAL CAUSES OF EPIPHORA
Supranuclear – emotions	Punctal stenosis	Ectropion	Absence of canaliculus	Allergic rhinitis
Reflex tearing, e.g. keratitis	Canalicular stenosis (common or singular)	Conjunctivochalasis	Canaliculitis	Iatrogenic, e.g. previous nasal surgery
Infranuclear, e.g. aberrant nerve innervation (crocodile tears)	Irregularity of duct	Acquired punctal occlusion	Dacryocystitis	Tumours
		Punctal malposition	Lacrimal sac tumours	

Table 1 Aetiology of watering eye

The watering eye

Symptoms associated with excessive tearing are not infrequently encountered in optometric practice. Since the aetiology of these symptoms is diverse, the practitioner should exercise a considerable degree of vigilance when examining the ocular adnexa so that the patient is managed expeditiously.

In order to reinforce the understanding of the various pathophysiologies associated with a watering eye, the reader should be acquainted with the definitions of hypersecretion and epiphora. This is important since treatment of the former is essentially medical whereas surgery remains the most effective stratagem for the latter.

Hypersecretion

This term is used interchangeably with hyperlacrimation and reflex tearing. In short, it represents excessive tear production. A common cause of bilateral hypersecretion is blepharitis. Hypersecretory disorders are not always bilateral. Unilateral causes include corneal foreign body and corneal abrasion.

Epiphora

The term epiphora should be reserved for a watering eye resulting from reduced tear outflow, i.e. inadequate tear drainage.

It is worthy of note that both epiphora and hyperlacrimation may co-exist. For example, a patient suffering from allergic conjunctivitis may exhibit hyperlacrimation in order to dilute the allergen in addition to epiphora due to an oedematous conjunctiva and lacrimal drainage apparatus.

Practitioners should also appreciate that the symptoms of epiphora only occur when outflow resistance exceeds tear production. It is not uncommon for elderly patients with acquired stenotic nasolacrimal ducts to be asymptomatic due to a concomitant decline in tear production.

The various aetiologies associated with a watering eye are summarised in **Table 1**.

Case histories

Case 1

History

Patient FH, a 60-year old Caucasian female, presents with a right watering eye of approximately six months duration. Although she is in no pain, she finds the routine of wiping her right cheek rather bothersome. Her general health is good and she takes no medication. Her family history for systemic and ocular disease is negative as well as her own previous ocular history.

Examination

Her lids appeared normal with no evidence of malposition such as ectropion, eversion of her puncta or horizontal lid laxity. The latter is assessed by pulling the lid from the globe. Excessive flaccidity is confirmed if the distance between the lower lid and globe is 10mm or greater. A dynamic test (known as the snap-back test) determines the speed with which the lid recoils back to its original position. Laxity is confirmed if it returns back to the original position after several seconds and/or requires several blinks. Medial and lateral canthal tendon laxity may be determined via pulling the lid laterally and medially respectively. Both the puncta, in the former case, and the canthal angle, in the latter, should not move greater than 1-2mm.

Palpation of the lacrimal sac yielded no evidence of regurgitating mucous or pus. Her lashes also appeared unremarkable. Further inspection of her tear meniscus, however, uncovered a raised marginal tear strip which was considerably greater than that exhibited in her contralateral eye.

Further investigations

In view of the relative paucity of overt ocular signs in a patient complaining of epiphora, it is important to establish whether the lacrimal drainage system is patent or not. This is achieved by performing a dilation and irrigation procedure as outlined below.

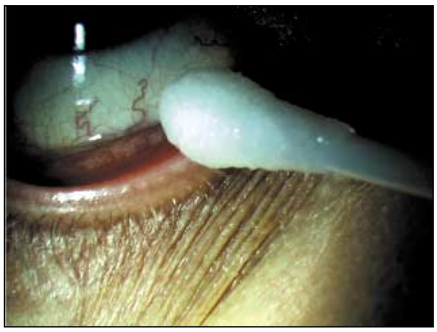

Figure 1
Topical anaesthetic applied to punctum

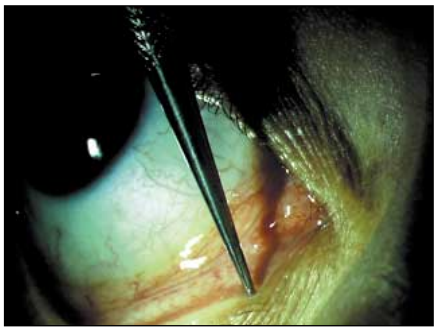

Figure 2 Punctal dilation

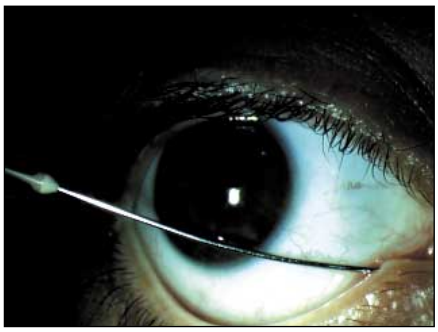

Figure 3 Insertion of lacrimal cannula

Figure 4 Acute dacryocystitis

Dilation and irrigation

The patient is firstly anaesthetised using a cotton wool bud soaked in anaesthetic and held in place for approximately one minute (**Figure 1**). Once anaesthetised, the lid is pulled down and laterally (to straighten the lower canaliculus) and a dilator is inserted vertically to dilate the puncta and ampulla (**Figure 2**) and then rotated through 90˚ and progresses further in order to dilate the lower canaliculus.

A lacrimal cannula attached to a syringe containing saline is inserted gently into the canaliculus and slowly advanced towards the medial wall of the nasolacrimal sac (**Figure 3**). If the cannula is able to touch the medial wall of the sac and bone then a hard stop is felt. A soft or 'bungie' stop is indicative of a blockage in the vicinity of the canalicular system. Such a feeling is accompanied by a slight disruption of the medial canthal angle by the probe. After such probing, the cannula is withdrawn slightly and saline irrigated into the drainage system. A drainage system is deemed patent to syringing if the patient reports either the taste or sensation of saline as it enters the nasopharynx.

In this case, both a hard stop was felt and the system was patent to syringing. Notwithstanding this result, it is important to realise that a functional blockage due to dacryostenosis may still be present. In other words, one of the components of the drainage system is relatively narrow and, as such, prevents the flow of tears under normal conditions. Since the hydrostatic pressure incurred by irrigating surpasses that produced by the aforementioned orbicularis actions involved in blinking, fluid is able to drain through the system.

In order to confirm the presence of a functional blockage, the patient was subjected to the Jones dye tests. Although readily employed in optometric practice, their use in the ophthalmological setting has been curtailed owing to the relatively high false negative rate of the primary test. Factors contributing to the aforementioned errors include, inter alia, individual blink rate and anatomical nuances associated with the nasal floor and inferior turbinate. Indeed, endoscopic examination is the de rigeur technique employed in ophthalmology clinics. This enables the ophthalmologist to directly observe fluorescein dye entering the inferior turbinate with the endoscope.

The Jones tests are contraindicated if the lacrimal system is blocked to syringing since this indicates that a total, non-functional blockage of the lacrimal drainage system exists.

The Jones Primary Test involves instilling guttae 2% fluorescein into the conjunctival sac and asking the patient to occlude their contralateral nostril and blow into a white tissue after five minutes following instillation. Alternatively, a cotton wool bud soaked in anaesthetic may be inserted in the ipsilateral nostril and laid to rest against the inferior turbinate and inspected for dye. In this case, no dye was recovered, indicating a negative result.

In view of the negative result obtained, it is common to perform the secondary test immediately afterwards. This involves irrigating the inferior canaliculus with saline with the patient's head tilted forwards. The patient is asked to expectorate into a white tissue. Dye was retrieved in this case, indicating that there was a physiological partial blockage below the level of the nasolacrimal sac. A negative result, on the other hand, would be suggestive of a relatively more proximal block somewhere in the region of the puncta or canaliculus, since the fluorescein never reached the sac.

Diagnosis and discussion

Patient FH was diagnosed with epiphora secondary to right dacryostenosis. Although the dilation and irrigation procedure may sometimes relieve the blockage by dislodging trapped mucous plugs, it is generally investigative. Patient FH was reviewed in the practice approximately one week later still complaining of epiphora. Although she felt relieved that the cause of her symptoms was benign, she was referred for lacrimal surgery since this is the most effective method to relieve her symptoms. If, on the other hand, her symptoms had been relieved, no referral would have been required.

She subsequently received a dacryocystogram whereby radio-opaque fluid is injected into the canaliculus. This ancillary test enables the lacrimal surgeon to locate the stenosis. Once the stenotic location was found, she was booked for a dacryocystorhinostomy (DCR) – an operation which forms a permanent conduit from the sac to nasal spaces thus allowing the tears to flow freely. This procedure may be approached either externally (via a skin excision) or endonasally (via the nose using an endoscope).

Case 2

History

Patient ZR, a 70-year old Caucasian female, presents with a painful enlarged swelling in the region of her left lacrimal sac. In addition to her pain, she also complains of epiphora. She mentions that she was referred to the eye hospital for a chronic watering eye 12 months ago by her previous optometrist. However, at the time she was not troubled by the watering eye and the ophthalmologist advised against her having surgery.

Examination

Slit lamp examination revealed a tender, hyperaemic mass emanating from and localised to the left lacrimal sac region (**Figure 4**). It was extremely painful to touch. The localised nature of the lesion suggested that an abscess had formed as opposed to a cellulitiscellulites, which is representative of a disseminated inflammatory reaction. It is noteworthy that no mucopurulent material regurgitated through the ipsilateral punctum.

A diagnosis of acute dacryocystitis was made and the patient was referred urgently to an ophthalmologist.

Discussion

A painful, inflammatory mass in the inner canthal region associated with epiphora is characteristic of acute dacryocystitis (inflammation of the lacrimal sac). Chronic dacryocystitis, by contrast, is associated with very little, if any discomfort and is secondary to the sac developing into a mucocele. Unlike its acute counterpart, some mucopurulent material may be expressed as a result of applying pressure in the region of the sac.

Causes of acute dacryocystitis include nasolacrimal duct obstruction, lacrimal sac

diverticulae, previous nasal surgery and dacryoliths. In view of the patient's previous ocular history, the most likely cause in her case is a chronic obstruction which has become secondarily infected. The most common causative agents are staphylococci, streptococci and the diptheriods.

Acute dacryocystitis carries a guarded prognosis since, without treatment, the inflammatory process may disseminate beyond the sac wall into the surrounding tissue and induce a pericystitis or preseptal orbital cellulitis. Since the sac lies anterior to the orbital septum, it is rare for infections of this kind to progress to an orbital cellulitis. Notwithstanding, such cases do occur especially in the immunocompromised[5].

Management

In view of the infective nature of the condition and its propensity to inflict potentially devastating ocular sequelae, the initial management encompasses the administration of broad spectrum antibiotics such as amoxicillin/clavulanate (augmentin). Since patient ZR was afebrile (not showing signs of a fever), she was given 500mg augmentin orally to be taken every eight hours. Febrile patients, by contrast, require hospitalisation and have their antibiotics administered intravenously. Under no circumstances must irrigation be conducted whilst the infection is present.

The antibiotic regimen is maintained for approximately 10 to 14 days. If after such time, the underlying infection appears recalcitrant to therapy and the subsequent risk of perforation is high, the surgeon performs a dacryocystotomy. This involves incising and draining the abscess followed by packing the cavity with a ribbon gauze soaked in antibiotic and leaving it in situ for approximately three days.

Failure to address the underlying cause results in recurrences in at least 50% of elderly patients. It is for this reason, therefore, that most surgeons elect to perform a DCR (either external or endonasal) in order to remedy the nasolacrimal duct obstruction. Such surgery is usually undertaken three to four weeks post resolution of the primary infection.

Case 3

History

Patient BE, a 56-year old Caucasian male presents with a watery right eye associated with a yellow discharge and ipsilateral conjunctivitis which has been present for two weeks. He was referred by his GP, who initially prescribed guttae 0.5% chloramphenicol qds, without success. He is hypertensive and administers atenolol to control his blood pressure. His previous ocular history appears unremarkable.

Examination

Slit lamp examination revealed an erythematous, pouting punctum (**Figure 5**) associated with a mucopurulent discharge following digital palpation superior to the nasolacrimal sac. Furthermore, the swelling appeared medial to the punctum. The conjunctiva appeared hyperaemic.

Diagnosis

A prominent erythematous punctum associated with only a mild tearing and discharge is indicative of suppurative canaliculitis. The most common causative agent is actinomyces israelii (streptothorix), which is a mouth commensal. Other infectious progenitors include fungi (e.g. candida) and viruses (e.g. herpes simplex, varicella-zoster).

Most cases of non-suppurative canaliculitis are idiopathic and sub-clinical. Other aetiologies include staphylococcal blepharoconjunctivitis, cicatrising disease (e.g. ocular pemphigoid), previous eyelid surgery and drugs. Indeed, 5-fluorouracil, employed in the management of bowel cancer, may induce fibrosis of the puncta and the canaliculus[5].

Treatment

Unlike acute dacryocystitis, whereby urgent referral is mandatory, patients presenting with canaliculitis should be seen by an ophthalmologist on a soon basis. This inflammation may be differentially diagnosed from acute dacryocystitis by the fact that pouting of the punctum is prominent in the former (and may be clinically pathognomonic) whereas generalised swelling and pain are more salient in the latter. Furthermore, in cases of chronic dacryocystitis associated with no pain, pouting of the punctum is not seen.

Treatment involves expressing the infectious material and culturing it. Next, the canaliculus requires emptying surgically. This is usually achieved via a canaliculotomy with marsupialisation of the canaliculus. Briefly, the canaliculus is incised horizontally and a fine chalazion curette is introduced to evacuate the concretions from the canaliculus. Once removed, the lacrimal drainage system is irrigated with penicillin G solution 100,000 units/ml or iodine 1% solution.

Post-operative treatment includes oral penicillin and topical polymyxin. If, on the other hand, a fungus is revealed on cultures, guttae nystatin tds, together with nystatin 1: 20 000 solution lavage several times per week is sufficient to expunge the infectious agent.

In the rare case where there is extensive canalicular damage, either a common canaliculo-dacryocystorhinostomy or a conjunctivodacryocystorhinostomy with a bypass tube, is undertaken by the surgeon. The former procedure involves anastomising the common canaliculus with the nasal mucosa. Its conjunctival counterpart, on the other hand, involves the concomitant administration of a Lester Jones pyrex glass tube. This is a procedure which creates an anastomosis from the conjunctiva into the nasal spaces, thus circumventing the canaliculus and nasolacrimal sac. The tube acts as an ersatz canaliculus.

Figure 5 Canaliculitis

(with permission from Kanski, Clinical Ophthalmology, Volume 2, External Eye Disease, Butterworth Heinemann)

Dry eye

Although dry eye has been historically categorised as either mucin deficiency, aqueous deficiency or evaporative dysfunction. The National Eye Institute[6] categorises dry eye as either a disorder of the tear film associated with either tear deficiency or excessive evaporation. This definition encompasses all aetiologies of dry eye including those secondary to systemic disease. **Table 2** lists a number of various aetiologies together with the appropriate dry eye category.

However, there are four main factors to consider when a patient presents with dry eyes which are:

- Tear film abnormalities
- Systemic abnormalities
- Ocular surface abnormalities
- Environmental factors

Examples of the above are illustrated in Table 3.

The following two case histories illustrate the various treatment modalities associated with dry eye due to tear deficiency and evaporative dysfunction.

Table 2 Some aetiologies of dry eye

TEAR DEFICIENT	EVAPORATIVE
Sjögren's syndrome: primary (unrelated to systemic disease) and secondary (due to underlying systemic disease)	Oil deficient, e.g. meibomitis
Lacrimal disease	Blink abnormalities
Lacrimal obstruction, e.g. trachoma	Surface abnormalities, e.g. xerophthalmia
Reflex abnormalities, e.g. neuroparalytic keratitis	

Figure 6 Rose Bengal staining in keratoconjunctivitis sicca

(with permission from Kanski, Clinical Ophthalmology, Volume 2, External Eye Disease, Butterworth Heinemann)

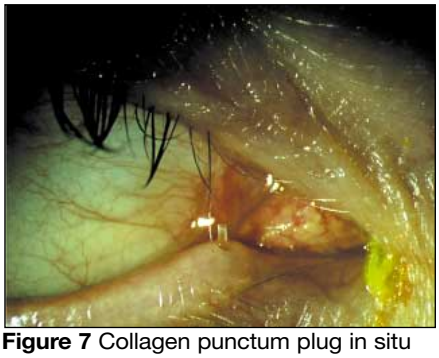

Figure 7 Collagen punctum plug in situ

Case 4

History

Patient RH, a 55-year old Caucasian female, presents to the practice complaining of sore, gritty eyes over the past month. She informs you that she saw her GP, who prescribed guttae hypromellose qds. However, although the artificial tears quelled her symptoms immediately following instillation, such assuagement was temporary. Further questioning reveals that she is osteoperotic and, as a consequence, has been placed on hormone replacement therapy (HRT) approximately four months ago. Her family history is negative for ocular or systemic disease.

Examination

Slit lamp examination revealed positive rose bengal staining on both bulbar conjunctival surfaces which encroached onto the limbal area (**Figure 6**). Her eyelids appeared normal with no evidence of blepharitis or meibomian gland dysfunction. Examination of her lower tear lake prior to instilling the aforementioned diagnostic agent revealed it to be of negligible height.

Diagnosis

Her signs and symptoms are consistent with the diagnosis of aqueous tear deficiency (keratoconjunctivitis sicca). She did not report a dry mouth (xerostomia) thus excluding the diagnosis of Sjögren's syndrome.

Hormonal influences play an important role in the aetiology of dry eye. It is noteworthy that this ocular malady is more prevalent in females than males. It was once assumed that oestrogen therapy may protect post-menopausal females from the onset of dry eye[7]. However, this assumption has been contested by numerous investigators. They found that women who took either oestrogen alone or oestrogen combined with progesterone/progestin, are at an increased risk of developing dry eyes[8].

Androgens, the male hormones, positively regulate tear production. This may well explain the female predilection for dry eyes in the young to middle age groups. With age, the amount of circulating androgens decrease, which may explain why the aforementioned female predilection to this condition declines in the older age group.

Figure 8 Insertion of intracanalicular plug

Treatment

Although her prescribed ocular lubricant (hypromellose) was relatively unsuccessful, she was recommended to instil a lubricating gel such as viscotears tds, together with Lacrilube ointment at night. Unfortunately, ointments have a tendency to smear the patient's vision. The gels, by contrast, provide little visual degradation and are useful for daytime use. Since they do not provide as long a contact time as ointments, the latter are the lubricant of choice at night.

The patient was reviewed in the clinic two weeks later and reported that she was compliant with the treatment regimen. Although she noticed an improvement in her symptoms, she mentioned that she found the process of instilling the agents rather laborious. Indeed, it has been shown that frequent topical applications correlate positively with poor patient compliance[9].

Since the risk of poor compliance was rather high with this patient, she was recommended to try punctum plugs. Instillation of punctum plugs increases the amount of tears by decreasing outflow. As a consequence, the action of the natural (and artificial) tears is prolonged by promoting longer retention on the eye. It is noteworthy that occlusion of one punctum will not reduce tear drainage by 50%. This is because the pump action produced by the blink will cause additional drainage to occur via the homolateral canaliculus.

In an attempt to disclose the placebo effect, the practitioner occludes the punctum/puncta of one eye only, unbeknown to the patient, with a collagen, dissolvable plug (**Figure 7**). An improvement in symptoms in the occluded eye only suggests a true beneficial effect. The patient was reviewed two weeks later (in order to provide sufficient time for the plug to dissolve) and reported that the occluded eye felt significantly more comfortable over the first week than the contralateral, non-occluded eye. Owing to the high extrusion rate associated with conventional silicone (non-dissolvable) punctum plugs, a silicone (non-dissolvable) intracanalicular plug was inserted in each inferior punctum (**Figure 8**).

The patient was subsequently reviewed after one week and one month. In both instances, she reported a marked improvement in her symptoms and mentioned that they obviated the need to instil lubricants on a daily basis. Furthermore, slit lamp examination revealed a marked reduction in the degree of conjunctival staining.

Discussion

In view of the patient's history, it is not unreasonable to assume that her ocular manifestations are the result of her taking HRT. Although her general practitioner was made aware of this potential complication, it was agreed that the benefits to her overall health through taking such therapy outweighed her ocular discomfort, especially as it had been ameliorated by the use of the punctal plug and occasional non-preserved lubricants.

Case 5

History

Patient GT, a 55-year old female, presents with a history of chronic ocular irritation together with conjunctival hyperaemia. She mentions that she is systemically well and takes no medication.

Table 3 Factors to consider when a patient presents with dry eye symptoms

TEAR FILM	SYSTEMIC	OCULAR SURFACE	ENVIRONMENTAL
Aqueous deficiency	Rheumatoid arthritis	Blepharitis	Environmental
Evaporative dysfunction	Sjögren's syndrome	Meibomianitis	Poor air quality
	Reduced androgen levels	Surgery, e.g. LASIK	Low humidity
	Medications, e.g. antihistamines	Goblet cell loss	

Examination

Slit lamp examination revealed inspissated (thickened secretion due to dehydration) meibomian secretions on squeezing the glands, in association with conjunctival hyperaemia (**Figure 9**). Although her tear prism height appeared normal, the tear break up time was rapid (less than five seconds) and the tear film appeared markedly greasy. Her external complexion appeared normal with no evidence of hypertrophic sebaceous glands, erythema or aceniform papules suggestive of rosacea. Moreover, further questioning failed to disclose symptoms of the latter dermatopathology such as facial flushing following ingestion of spicy foods or alcohol.

In view of the signs and symptoms, a diagnosis of primary meibomian gland dysfunction (meibomianitis) was made.

Discussion

Histopathological studies have confirmed that meibomian gland dysfunction (MGD) is due to obstruction of the meibomian orifices by desquamated epithelial cells that have become keratinised. As a result, the lipids in the gland thicken and the sebaceous secretions stagnate. Importantly, the commensals of both the eyelids and meibomian glands produce hydrolytic enzymes, resulting in the release of free fatty acids from the stagnated lipids. These free fatty acids are toxic to the ocular surface and may act as progenitors of ocular inflammation and tear film instability. MGD has been implicated in a number of ocular conditions, including chronic blepharitis,

It is important to rule out rosacea since MGD may be present in over 50 % of cases.

Treatment

This should be directed at relieving the obstruction of the ducts and orifices by self-expression of the glands twice a day in conjunction with home therapy of hot compresses and lid margin scrubs twice a day. Practitioners may wish to express the contents of the meibomian glands in the consulting room especially in cases with grossly overt keratinised plugs. This is achieved by anaesthetising the patient and positioning him/her comfortably at the slit lamp. The practitioner proceeds to place a moistened cotton wool bud in the inferior cul-de-sac in the region of the gland to be expressed and using his/her other hand, places a dry bud outside of the lid so that it is in opposition to its moistened counterpart. The buds are gently squeezed together and rolled upwards towards the lid margin. Expressed sebum is wiped away with a third sterile cotton wool bud. Ocular lubricants are usually prescribed to further reduce the symptoms.

In addition to the aforementioned hygiene therapy, ophthalmologists may wish to introduce a topical antibacterial ointment to the patient's regime such as erythromycin. In recalcitrant cases, oral tetracycline/minocycline 250mg qds for 30 days or doxycycline 100mg bds for 30 days may improve the situation. The tetracyclines possess both antimicrobial and anti-collagenolytic properties. It is the latter property which reinforces the drug's usefulness in the treatment of persistent corneal epithelial defects. The tetracyclines appear to ameliorate the patient's symptoms by reducing the quantity of lipolytic enzymes produced by the bacteria. As a result, the quantity of free fatty acids in the sebum is reduced.

If rosacea is suspected, the patient should be referred to a dermatologist. These patients respond favourably to both topical and systemic metronidazole in addition to surgery when necessary.

Novel dry eye treatments

The treatment modalities outlined above are purely palliative. Since some causes of dry eye are inflammatory in origin (Sjögren's syndrome), the prescription of anti-inflammatory agents appears to be a plausible therapeutic regimen. Topical steroids are deemed undesirable for such long-term therapy due to their numerous ocular side effects.

Topical Cyclosporin A 0.05% and 0.1%, which reduces the immune response through its inhibitory action on T-lymphocytes, has been shown to dramatically improve both conjunctival rose bengal staining and superficial punctate keratitis both during treatment and afterwards[10]. Moreover, it possesses an excellent safety profile. Presently, Allergan is performing a confirmatory trial of its phase three results.

Other novel, topical agents currently under investigation include testosterone eyedrops and retinoic acid. The former is currently entering phase two FDA trials while the latter seems beneficial to those suffering from cicatricial disease[11].

Conclusion

This article has outlined some causes of tear film abnormalities which may be encountered in everyday practice. The diverse management options offered by the optometrist in the majority of cases are testimony to the important role which such eyecare practitioners have to play in the primary care setting.

About the author

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References

1. Jones, LT (1961) An anatomic approach to problems of the eyelids and lacrimal apparatus. *Arch. Ophthalmol.* 66: 137.
2. Doane, MG (1981) Blinking and the mechanics of the lacrimal drainage system. *Ophthalmology* 88: 844.
3. Becker, B (1992) Tricompartment model of the lacrimal pump mechanism. *Ophthalmology* 99: 1139-1145.
4. Thale, A et al (1998) Functional anatomy of the human efferent tear ducts: a new theory of tear outflow mechanism. *Graefe's Arch. Clin. Exp. Ophthalmol.* 236: 674-8.
5. Gigantelli, JW (1999) Orbital and Lacrimal Gland: The Lacrimal Drainage System. In Yanoff, M and Duker, JS, eds. Ophthalmology. Mosby, London.
6. Lemp, M (1995) Report of the National Eye Institute/Industry Workshop on Clinical Trials in Dry Eyes. *CLAO J.* 21 (4): 221-32.
7. Akramian, J, et al (1998) Estrogen therapy in keratoconjunctivitis sicca. *Adv. Exp. Med Med. Biol.* 438: 1005-9.
8. Schaumberg, DA et al (2001) Hormone replacement therapy and dry eye syndrome. *JAMA* 7; 286(17): 2114-9.
9. Swanson, M (1998) Compliance with and typical usage of artificial tears in dry eye conditions. *J. Am. Optom. Assoc.* 69 (10): 649-55.
10. Stevenson, D et al (2000) Efficacy and safety of Cyclosporin A ophthalmic emulsion in the treatment of moderate to severe dry eye disease: a dose ranging, randomized trial. The Cyclosporin A Phase 2 Study Group. *Ophthalmology* 107 (5): 967-74.
11. Murphy, PT et al (1996) Successful use of topical retinoic acid in severe dry eye due to chronic graft versus host disease. *Bone Marrow Transplant* 18 (3): 641-2.

Figure 9 Meibomian gland dysfunction

Bibliography

- Olver, J (2002) Colour Atlas of Lacrimal Surgery. Butterworth Heinemann, Oxford.
- Oyster, CW (1999) The Human Eye: Structure and Function. Sinauer.

Notes to CPD participants

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Multiple choice questions
Ocular therapeutic case studies
Tear film abnormalities

Please note there is only one correct answer

1. Which one of the following statements is true concerning the lacrimal system?
a. The upper canaliculus is longer than the lower
b. The valve of Hasner is important in preventing reflux of air and nasal contents
c. Lacrimal glands reside in the superio-medial orbital region
d. The orbicularis oculi are innervated by the trigeminal nerve

2. Which one of the following statements is false regarding either tear or lacrimal gland physiology?
a. Tear drainage involves both active and passive processes
b. Eyelid movements are important for tear drainage only
c. The lacrimal gland receives both parasympathetic and sympathetic innervation
d. Secretion of tears is mediated by the facial nerve

3. Which one of the following statements is true regarding epiphora?
a. It is due to reflex tearing
b. Patients are always symptomatic
c. It is due to inadequate tear drainage
d. Blepharitis is a common cause

4. All of the following can give rise to epiphora except which one?
a. Ectropion
b. Dacryocystitis
c. Previous nasal surgery
d. Goblet cell loss

5. Which one of the following statements is true regarding nasolacrimal duct syringing?
a. It is used to determine the patency of the drainage system
b. It always alleviates the patient's symptoms
c. A Jones test should be performed if the lacrimal system is blocked to syringing
d. It is not used in the Jones tests

6. Which of the following signs and symptoms is suggestive of acute dacryocystitis?
a. Minimal discomfort
b. Inflammatory mass in inner canthal region
c. Expression of copious amounts of mucopurulent material upon digital palpation
d. Mass in anterio-superior lateral orbit

7. Treatment of dacryocystitis may include all of the following except which one?
a. Systemic antibiotics
b. Dacryocystotomy
c. DCR
d. Irrigation when acute

8. Which of the following signs and symptoms is not suggestive of canaliculitis?
a. Swelling lateral to the puncta
b. Pouting punctum
c. Ipsilateral conjunctivitis
d. Mucopurulent discharge

9. Causes of dry eye include all of the following except which one?
a. Reduced androgen levels
b. Sjögren's syndrome
c. Dacryostenosis
d. Low humidity

10. Which one of the following therapies is not suitable for a patient suffering from dry eyes?
a. Punctum plugs
b. Lid hygiene
c. Tetracycline
d. Hormone replacement therapy (HRT)

11. Which one of the following statements is true regarding dry eyes?
a. Males are more affected than females in the young to middle age groups
b. Women administering HRT may be more at risk
c. Anti-inflammatories have no benefit in patients suffering from Sjögren's syndrome
d. Retinoic acid is the drug of choice in treating dry eye irrespective of cause

12. Which one of the following conditions does not require referral?
a. Dacryocystitis
b. Canaliculitis
c. All cases of functional block
d. Preseptal cellulitis

An answer return form is included in this issue. It should be completed and returned to: CPD Initiatives (c4082f), *OT*, Victoria House, 178–180 Fleet Road, Fleet, Hampshire, GU51 4DA by November 2, 2002.