Ocular disease in cattle

This article looks at common medical condition affecting the bovine eye including corneal ulceration, stromal abscesses, infectious bovine keratoconjunctivitis, squamous cell carcinoma, and bovine iritis. It also covers anatomical features, first aid procedures and examination techniques.

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Infectious and traumatous ocular conditions are common in cattle. This article will address the more common ones, as well as giving a summary of anatomy, examination and first aid. Inherited defects are not covered — details can be found in conventional text books on bovine medicine. While surgical procedures are mentioned as treatment options, it is beyond the scope of this article to detail the surgical techniques involved and the reader is referred to Shaw-Edwards (2010).

Anatomy

To aid understanding of this section, the reader may wish to refer to the relevant diagrams on ocular structures in the anatomy book by Budras and Habel (2003), available as free-access online version.

The eyeball is cushioned by retro-bulbar fat. In addition to pathology affecting ocular structures, hydration status and body condition may affect the position of the eye in the orbit. The conjunctival sac is formed by the palpebral conjunctiva on the inside of eyelids, and the bulbar conjunctiva overlying the sclera. Eyelashes (cilia) are present in both the upper and lower eyelid in the bovine.

The third eyelid, also called the nictitating membrane, is a fold of conjunctiva in the medial canthus. It contains T-shaped cartilage. At the base of the cartilage sits the third eyelid gland, which extends several centimetres into the bulbar fat.

The cornea consists of the outer epithelium (several cell layers), the stroma (occupying about 90% of the corneal depth) and, innermost, the Descemet's membrane and single layer endothelium. Going inwards from the translucent cornea, the structures are anterior chamber containing aqueous humor, the pupil formed by the iris, the lens and ciliary body, the posterior chamber containing vitreous humor, and the retina (eye background). The bovine pupil is elliptical, but becomes round when dilated. There are small black projections on the upper and lower margin of the pupil. The bovine iris is heavily pigmented and, therefore, dark in appearance.

The background of the bovine eye shows the optic nerve (slightly below and lateral to the posterior pole of the eyeball), the tapetum lucidum (dorsal to the optic disc), tapetum nigrum, and various arteries and veins that supply the retina.

Tear production takes place in the lacrimal gland (positioned in the dorso-lateral quadrant of orbit), the gland of the third eyelid, and some diffuse gland tissue. The tear apparatus consists of a dorsal and ventral lacrimal puncta, each leading into a small duct. These ducts combine in the lacrimal sac, which drains into the naso-lacrimal duct. The cranial nerves of interest to ocular function are shown in *Box 1*.

Examination of the eye

Hands must be clean and, ideally, disposable gloves worn when examining eyes to prevent introduction of contaminants. Tools for eye examination include good head restraint (e.g. crush and halter), focal light source like pen or head torch, topical anaesthetic, cotton buds, plain artery forceps, fluorescein strips, and an ophthalmoscope. More detailed examination may require an ultrasound machine (*Figure 1*), Schirmer Teartest strips, a tonometer and a slit-lamp. If blepharospasm is severe, an auriculopalpebral block will aid opening of the eyelids (*Figure 2*).

Box 1. Cranial nerves relevant to vision, eye movement, sensation and reflexes

- II Optic nerve: vision
- III Oculomotor nerve: eye movement (dorsal, medial, ventral and ventral oblique), pupil constriction
- IV Trochlear nerve: eye movement (dorsal oblique)
- V Trigeminal nerve: ophthalmic division provides sensory input to orbit, cornea, eyelids and medial canthus. Maxillary division provides sensory input to lateral eyelids
- VI Abducent nerve: eye movement (lateral and retraction), protrusion of third eyelid
- VII Facial nerve: facial expression. Auriculo-palpebral branch providing motor supply to eyelids. Also vegetative input to lacrimal gland.

When examining the anterior segment with the ophthalmoscope, the aqueous flare should be black. A white flare indicates debris in the anterior chamber. For direct ophthalmoscopy of the fundus of the eye, one starts with a setting of largest circle and 0 to -1. If the fundus vessel appears blurred, the settings are clicked up (green number, to focus more superficially) or down (red number, to focus deeper) until the vessels are clear. Most fundi will be in focus at a setting of -1 to -2.

Figure 1. Ultrasound of the eye is easily performed and well tolerated. It enables assessment of neoplastic spread, inflammation, and normal position, size and integrity of ocular structures. Under topical anaesthesia and using a coupling gel, a linear probe is placed onto the globe (either directly onto cornea or onto the eyelid). The highest available MHz setting is used (e.g. 'tendon mode').

Figure 2. Auriculo-palpebral nerve block. The pink arrow marks the injection site, roughly half-way between the lateral canthus and the base of the ear, where the nerve crosses the top of the zygomatic arch. For surgical procedures, it must be remembered that only motor function is blocked, i.e. additional anaesthesia to block eyelid sensation must be used.

Human interdental brushes are very useful for taking ocular swabs. For cytology, a smear is prepared and stained with DiffQuik. If swabs are taken for culture, it is important to harvest them prior to any topical anaesthetic or other medication being applied.

Ocular foreign bodies are common in cattle, necessitating exploration of the conjunctival sac, best performed with topical anaesthetic. This is done by pushing the eyeball back into its socket via a finger placed onto the opposite eyelid (e.g. for exploring ventral conjunctival sac, the finger is placed onto the dorsal eyelid and the eyeball pushed back). Several attempts are typically required to ensure thorough exploration of the conjunctival sac. It can be helpful to run a moistened cotton bud through the sac to dislodge foreign bodies. Once the eyeball is pushed back, a finger or cotton bud can be inserted into the gap formed between eyeball and third eyelid, and the third eyelid lifted off further. A pair of plain artery forceps may also be used to grasp and lift the third eyelid.

Occasionally, it is of interest to establish the intra-ocular pressure (IOP), for example where glaucoma is suspected. In dairy cattle, an average IOP of 27 mmHg, with a range of 16–36 mmHg, has been reported using applanation tonometry like the TonoPen (Gum et al, 1998).

To assess tear production, a Schirmer test strip is placed into the lower conjunctival sac. The reading should be greater than 20 mm after 1 minute. It is important to carry out the Schirmer tear test prior to excessive manipulation of the eye or instilling any agents, such as local anaesthetic. Patency of the lacrimal duct system is assessed by staining tears with fluorescein and waiting for green-coloured tear fluid to appear at the ipsi-lateral nostril (typically within 5–10 minutes).

First aid

Advice to owners on first-aid includes:

- Protect the eye from further injury, especially self trauma. Restrain the head of the animal so it cannot rub the eye.
- Do not force a swollen and painful eye open. Wait for veterinary attention, with the use of sedatives and/or local analgesia to aid examination.
- Never use disinfectants in or around the eye.
- For bruising or a blow to the eye, gently apply a cold towel or ice pack to the area. If the blow was severe, veterinary attention to check for further head trauma is advisable.
- For a suspected foreign body, which is causing only minor irritation, try to flush the foreign material out of the eye. Gently pull down the lower eyelid and pour a steady stream of lukewarm water over the eye (e.g. using a jug). Flush for up to 15 minutes, checking every 5 minutes whether the material has gone. In an emergency, any clean drinkable fluid (e.g. soft drinks), may be used. If a foreign body is embedded in or around the eyeball, prompt veterinary attention is necessary.
- Chemical injuries need to be flushed promptly, as above. From a prognostic point of view, alkaline fluids cause more severe trauma than acidic fluids.
- Eyelid tears should receive veterinary attention within the 'golden window' for wounds, i.e. within 6 hours of the injury

for best chances of wound healing and the eyelid regaining a normal contour once sutured (*Figure 3a, b*). Never cut off any torn pieces of eyelid.

Infectious bovine keratoconjunctivitis (IBK)

Synonyms for IBK include 'New Forest Eye' and 'Pink Eye'. The main causative agent is *Moraxella bovis*. However, conjunctival swabs of affected cattle often yield additional pathogens, including *Mycoplasma* spp., *Chlamydia* spp., and herpes virus.

Lesions are more commonly unilaterally than bilaterally. Clinical signs include epiphora, blepharospasm, conjunctivitis, and keratitis with corneal oedema and cloudiness. Corneal lesions are typically centrally located (versus those caused by foreign bodies which may occur at any location on the cornea), and range from a small white to grey spot in early keratitis to large, often ulcerating lesions in advanced cases. Full thickness ulceration is a risk, with prolapse of the Descemet's membrane. Granulation tissue gives the pink appearance referred to in the colloquial name of the condition. Neovascularisation, with blood vessels advancing from the periphery into the centre of the cornea, is often marked in cases of IBK. It typically takes 3 to 4 days after the onset of IBK for neovascularisation to start, with vessels advancing about 1 mm per day.

IBK occurs mainly during summer and early autumn. It is contagious, and both flies and close proximity of cattle (e.g. at feed troughs) play an important role in its spread through a group. Other vectors, such as troughs and handler's hands can also be important. The disease will spread through a group within a few weeks, often affecting 50–80% of animals. There appears to be life-long immunity to IBK, and some colostral transfer of protection probably occurs (Kopecky et al, 1983).

Treatment consists of antibiosis over several days, either as topical ointment or as bulbar sub-conjunctival injection (*Figure 4a, b, c*). Cloxacillin remains effective as ointment, and a potentiated penicillin is a good choice for sub-conjunctival injection (please note that the sub-conjunctival route constitutes off-licence use for currently available antibiotics). Antibiotics that are likely to achieve sufficient concentration at the lesion site after systemic administration include florfenicol, but a full bodyweight dose must be given. This means higher drug costs, but can be a less hazardous route of administration in some patients. The patient should ideally be stabled to reduce light irritation, and fly control measures instigated.

Bovine iritis

Also called 'silage eye', this is a uveitis and iritis believed to be caused by *Listeria monocytogenes*. Microtrauma to the cornea is likely involved, as well, as instilling *Listeria* pathogens into a healthy bovine eye will not result in the pathology seen in clinical cases. It is associated with silage feeding, in particular the use of big bale silage, ring feeders, or self feeding from the clamp face, and tends to be seasonal between winter and late spring. Morbidity can reach 100% (Erdogan et al, 2001).

Affected cattle present with blepharospasm, photophobia, excessive lacrimation and conjunctivitis. Closer ocular examination typically shows an anterior uveitis, corneal opacity and characteristic swelling and undulating folds of the iris (*Figure* 5). A small proportion of cattle may exhibit concurrent neurological signs. The main differential diagnosis is IBK, but season, intact corneal surface, uveal changes and silage feeding usually allows a distinction.

Treatment consists of antibiotics, with oxytetracycline or penicillin a suitable choice. In addition, dexamethasone is useful (use non-steroidal anti-inflammatory drugs (NSAIDs) if animal is pregnant or corneal ulceration is present). The author prefers

Figure 3a. The prompt presentation of this lower eyelid tear facilitates primary wound closure to ensure normal eyelid contour and function. For tears near the medial canthus, the integrity of the naso-lacrimal system needs to be checked.

Figure 3b. A healed tear in the lower eyelid in a calf. There is some tear leakage over the eyelid margin, but overall a satisfactory contour has been achieved. Function has also been preserved, as evidenced by a well-lubricated cornea.

(Image courtesy of D. Grove-White)

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Figure 4a to c. Performing a bulbar sub-conjunctival injection. Uptake of drugs from the bulbar site is far superior compared with the palpebral conjunctiva. a) The head is rotated to expose the sclera. Using an episcleral vessel as reference point, local anaesthetic is dabbed onto the sclera with a cotton bud; b) Syringe and needle (22 to 23 gauge) are held parallel to the sclera, and the needle is inserted at the point of local anaesthesia; c) A blep is formed by the injected drug.

Figure 5. Undulating folds of the iris in a case of bovine iritis ('silage eye').

Figure 6. Uptake of fluorescin is an indication that the corneal surface (epithelium) is damaged, as in this case of a corneal ulcer. There is a degree of stain underrunning the epithelium, indicating a non-healing ulcer.

to administer these treatments by bulbar sub-conjunctival injection, but it may also be given by topical and/or systemic routes. Atropine sulphate 1% drops given twice daily (bid) are useful to reduce the risk of iris adhesions, and aid analgesia by reducing ciliary spasms (taking into account that atropine is unlicensed in food producing animals, and may possibly have a negative effect on gastro-intestinal motility). Lesions typically heal within 2 weeks. Control involves good silage making protocols ensuring effective fermentation, low soil contamination and preventing aerobic pockets, and changing to trough or feed-passage feeding.

Dealing with corneal/stromal ulceration

Viewing the surface of the cornea from different angles, including sky-line views, will aid the detection of any ulceration. Fluorescein greatly aids detection: either fluid or a strip is placed into the conjunctival sac. The animal is allowed to blink or the eyelids are closed a few times manually. Only the corneal stroma takes up stain, i.e. the stain will adhere if the corneal epithelium has been compromised (*Figure 6*).

The depth of the ulceration guides the treatment regimen. For ulcers up to 50% depth, medical treatment in the form of antibiosis (topical or subconjunctival) plus collagenase inhibitors is indicated. For the latter, autogenous serum, 0.2% EDTA or tetracyclines may be used. A few drops are applied 4–8 times a day. Healing of an uncomplicated ulcer will be achieved within 5 to 10 days.

For ulcers with a depth over 50% (*Figure 7*), or progressive ones, additional surgical intervention is indicated. This may consist of a third eyelid flap or tarsorraphy (suturing the eyelids together), both of which can be carried out successfully on farm. It is useful to secure the suture ends with a bow tie, rather than a surgical knot, allowing release of the suture on a regular basis to administer medical treatments as above. Alternatively, a sub-palpebral lavage system may be inserted (for example eye lavage kit from Mila) (*Figure 8*; see Dwyer, 2013 for further details). Advanced surgical options include keratectomy or conjunctival grafts/flaps. Healing of deep ulcers typically occurs in 2 to 6 weeks.

Figure 7. A full thickness ulcer, exposing the Descemet's membrane.

Figure 8. A sub-palpebral lavage system in a bull with corneal ulceration.

Occasionally, a chronic non-healing ulcer develops, marked by fluorescein stain running some distance underneath newly formed epithelium (*Figure 6*), indicating that the epithelium is not firmly connected with the underlying stroma. Removal of the loose parts of the epithelium, for example with a dry sterile cotton swab, is indicated. This may be complemented with a grid keratotomy, followed by antibiosis and protection of the cornea (e.g. third eyelid flap).

The administration of subconjunctival NSAIDs (e.g. 50 mg of flunixin meglumin) appears to provide some analgesia based on field observations. One could also consider the administration of 1% atropine sulphate drops twice daily to prevent iris adhesions.

Figure 9. Two stromal abscesses along the ventral margin of the cornea in a beef animal.

Culture for bacteria and fungi is strongly recommended for non-healing or progressive ulcers. In companion animal species, fungal infections are treated with imidazole antifungal agents plus possibly dimethyl sulfoxide (DMSO).

Bullous keratopathy

This may be a complication of corneal ulceration or a general keratitis. It results from the corneal response to inflammation, with formation of vesicles and bullae. There is severe generalised corneal oedema involving the epithelium and superficial parts of the stroma.

Treatment consists of topical 5% sodium chloride every 6–8 hours. Oxytetracycline and NSAID (e.g. flunixin meglumin) are given systemically, plus possibly topical atropine sulphate 1%. The healing process is slow.

Dealing with stromal abscesses

Stromal abscesses are caused by either a micropuncture and inoculation of the stroma with pathogens or foreign body, or by healing corneal ulcers or trauma with infection trapped under the healed epithelium. After a puncture, there is fluorescein uptake in the initial phase while the epithelium is damaged, but healing occurs quickly and commonly there is no uptake when the patient is presented. There may be multiple abscesses and some may be 'floating' (*Figure 9*).

For management of these abscesses, the main points to consider are that: the infection resides in the deeper layers with an intact epithelium, therefore culture or cytology are typically not helpful; and the intact epithelium inhibits antibiotic penetration, therefore systemic administration rather than topical must be used. Fluorquinolones and florfenicol have been suggested as suitable antibiotics. Debridement is often useful to facilitate healing. For this, topical anaesthetic is applied, and a sterile dry cotton swab rubbed vigorously over the area (*Figure 10*). NSAIDs are also beneficial.

The healing process is slow, typically taking 4–6 weeks. If there is no response to medical treatment or severe uveitis develops, surgical treatment like a keratectomy is indicated. Indications that treatment may be stopped include a colour change of the abscess from yellowish to white, and disappearance of corneal vessels.

Neoplastic disease

Squamous cell carcinoma (SCC) is the most common type of neoplasia affecting the eye. It is an epithelial neoplasm and may affect all ocular tissues. Its occurrence is linked to increased exposure to UV light, and cattle with little periorbital pigmentation, like Herefords and Holsteins, are particularly affected. It is still unclear how much other factors like viral agents play a role, with some evidence of a hereditary component (Blackwell et al, 1956). Affected cattle are typically mature.

Common sites are the third eyelid, the junction between sclera and cornea, and the lower eyelid. Early lesions include raised white nodules or plaques, progressing to wart-like proliferations. Both these early forms may regress spontaneously. The final carcinoma is typically nodular and pink in colour (*Figure 11*).

Diagnosis can be confirmed by biopsy. An impression smear may give an indication, but severe inflammation will produce a similar cytological appearance as SCC. The regional lymph nodes should be checked for metastasis which occurs in a proportion of animals. Metastasis will lead to rejection at slaughter, and will influence prognosis for any treatment attempts.

For lesions affecting the conjunctiva, third eyelid or cornea, surgical excision may be considered. Ideally a margin of a couple of millimetres into healthy tissue should be achieved. This necessitates a partial keratectomy for corneal lesions. For lesions affecting the sclera or where excision is not possible, additional therapy like cryosurgery or radiotherapy (*Figure 12*) is necessary for a reasonable prognosis. Alternatively, enucleation may be chosen. Small eyelid lesions can be surgically removed, providing eyelid contour and function are not compromised. Otherwise, enucleation is the best option for eyelid lesions. With regard to long-term prognosis, recurrence after surgical excision may affect about one in three patients.

Ocular lesions secondary to systemic conditions

When presented with eye lesions, one must consider whether this is a manifestation of a systemic disease. Typically, lesions are bilateral and the animal will show, or have a history of, additional non-ocular clinical signs, in particular pyrexia. Examples of systemic disease with ocular involvement are:

- Septicaemia resulting in hypopyon (accumulation of purulent material in the anterior chamber)

Figure 10. Debridement over a stromal abscess with a dry sterile cotton bud, performed under topical anaesthetic.

Figure 11. Neoplasia affecting the conjunctiva, upper eyelid, and orbital tissues in a beef cow. A degree of exophthalmos is present.

Figure 12. Beef cow from Figure 11 undergoing radiotherapy, after surgical debulking.

- The 'head and eye' form of malignant catarrhal fever, with conjunctivitis and corneal opacity
- Infectious bovine rhinotracheitis, with conjunctivitis
- Respiratory syncytial virus infection, with conjunctivitis
- Dry eye keratitis secondary to disease affecting blinking ability such as tetanus, or facial paralysis caused by listeriosis or trauma to the auriculo-palpebral nerve from fighting against a head yoke
- Endotoxaemia with injected conjunctiva
- Bovine viral diarrhoea causing congenital cataracts
- Bleeding disorders such as bracken poisoning, resulting in hyphaemia
- Blindness caused by central lesions.

Conclusion

Infectious and traumatous ocular conditions are common in cattle. Prompt diagnosis and treatment are essential for a favourable outcome. This may include first aid from the owner, although veterinary surgeon intervention is almost always necessary. LS

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KEY POINTS

- Clients should be briefed on first-aid measures for ocular problems.
- Two commonly encountered ocular diseases in cattle are infectious bovine keratoconjunctivitis (IBK) and bovine iritis ('silage eye'). Where diagnosis and treatment is prompt, cases carry a reasonable prognosis.
- To ensure best prognosis, more aggressive and involved treatment protocols are recommended for corneal ulceration.
- Systemic conditions leading to eye involvement need to be ruled out in cattle presenting with bilateral ocular disease.