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OCULAR TEAR

There are multiple corneal ulcer types, from simple superficial ulcers to deeper descemetocelles and perforations.

CONTINUING EDUCATION

OPHTHALMOLOGY

Managing Canine Corneal Ulcers

**MEET THE AUTHOR**

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Corneal ulceration, or a break in the corneal epithelium, can have a variety of etiologies, including trauma, entropion, ocular foreign bodies, and dry eye disease. The purpose of this article is to review corneal anatomy and physiology, basic classifications of corneal ulcers, what owners need to know about caring for dogs with ulcers, and monitoring and rechecking patients with corneal ulcers.

CANINE CORNEAL ANATOMY AND PHYSIOLOGY

The average canine cornea is 0.62 mm thick (for reference, a dime is 1.35 mm thick). It consists of 4 layers: the epithelium, the stroma, Descemet's membrane, and the endothelium.¹ It is covered by the tear film, an important layer that has many functions. The primary role of the tear film is to provide nutrition and oxygen to the cornea.

The corneal epithelium is made of stratified, nonkeratinized squamous cells. The epithelium is 5 to 7 cell layers thick and can regenerate when injured. Its purpose is to provide a barrier against chemicals, water, and microbes. The epithelium is hydrophobic (water-repelling); therefore, fluorescein stain does not adhere to it.

The stroma is composed of fine, evenly spaced collagen fibers. It is avascular and produces growth factors, extracellular matrix components, and kinases. These are essential for corneal development and homeostasis. The stroma is hydrophilic (water-absorbing); therefore,



fluorescein stain adheres to it when there is a break in the epithelium.

Descemet's membrane is the basement membrane of the posterior epithelium. It is composed of collagen fibers produced by the endothelial cells that lie below it. Descemet's membrane also repels fluorescein stain. An ulcer that completely penetrates the stroma but has not perforated the endothelium is called a *descemetocoele*. Descemetocoeles are often described as “halos” or “donuts,” as the stroma on the sides of the ulcer take up stain and the deep center does not.

The endothelium is a single cell layer. It cannot regrow. The endothelium is responsible for keeping excess fluid out of the cornea through sodium–potassium pumps.²

CORNEAL ULCER BASICS

Any time a dog presents with a red or painful eye or ocular discharge, the cornea should be stained to look for an ulcer. If an ulcer is found and appears to have stromal loss or a cellular infiltrate (i.e., it appears yellow or white), a sample should be collected for cytology and aerobic culture. Proparacaine may be applied before sample collection. A recent article found no significant difference in bacterial isolates before or after application of proparacaine.³ If the ulcer appears to be a descemetocoele, great caution should be taken in sample collection. If the case is going to be referred to an ophthalmologist, it is not wrong to wait and let the specialist collect the samples.

Ophthalmologists recommend starting patients with corneal ulcers on broad-spectrum prophylactic antibiotics.⁴ For an ulcer that is already infected, treatment should be based on cytologic findings until culture results are available. Culture swabs should be refrigerated until plated. Plating should take place as soon as feasible.

It is highly recommended that any canine patient with a corneal ulcer be fitted with an Elizabethan collar (E-collar) until the ulcer is healed.⁵ Many styles of E-collars are available. For corneal protection, something that will shield the eyes is recommended. Collars made of soft cloth and “donut” styles do not protect the eyes.

CORNEAL ULCER TYPES

Simple Superficial Ulcers

Simple, uncomplicated ulcers are superficial, only affect the epithelium, and should heal in 5 to 7 days with or without medical intervention if no complicating factors such as infection or mechanical irritation are present.⁶

Within an hour of injury to the corneal epithelium, epithelial cells begin to migrate to the defect. New cells slide over in a leapfrog fashion. The new epithelium is loosely attached; therefore, an E-collar is recommended until the ulcer is healed. Owners should watch for increased blepharospasm (squinting) and any of the following color changes: increased redness of the conjunctiva, a blue tint or haziness in the cornea (corneal edema), yellowness in the cornea (cellular infiltrate), or yellow/green discharge.

The patient should become increasingly comfortable over the week. Antibiotics and E-collar use should be continued until the cornea is stain negative.

Stromal Ulcer

Ulcers that result in stromal loss are classified as stromal ulcers, and the amount of stromal loss should be noted. Cytology should be performed on stromal ulcer samples to look for bacteria, fungus, and neutrophils. Appropriate antibiotic therapy should be chosen according to cytology results.

If significant neutrophils are seen on cytology, serum should be applied in addition to antibiotics to prevent melting. Serum inhibits collagenase breakdown of the cornea by neutrophils. It is ideal to have frozen serum available to dispense for treatment of possible or already melting ulcers. Serum can be used across species, but serum from cats with unknown feline leukemia and feline immunodeficiency virus status should not be used to treat other cats due to the potential to spread these viruses.⁷ Serum can be stored frozen at any temperature for up to 180 days without

Any time a dog presents with a red or painful eye or ocular discharge, the cornea should be stained to look for an ulcer.



losing efficacy.⁷ Once thawed, serum should be kept refrigerated for only up to 7 days to avoid possible contamination and bacterial growth. At the author's practice, equine and canine sera are stored frozen in 0.2-mL aliquots. Twenty 0.2-mL aliquots are dispensed at a time. Clients are advised to only remove 1 or 2 syringes from the freezer at a time and store them in the refrigerator. Three to 4 drops can be administered from a 0.2-mL aliquot.

Stromal ulcers require vascular growth to heal. Vessels start to grow from the limbus 3 to 6 days after insult to the cornea. They continue to grow at a rate of 1 mm per day until the defect is reached. These ulcers should be reexamined at least twice a week to check for progression of healing or worsening.

The corneal stroma is well innervated, so stromal ulcers can be painful and need systemic pain medications. Systemic nonsteroidal anti-inflammatory drugs (NSAIDs) can help with pain as well as any reflex uveitis that may occur secondary to the ulcer. Topical atropine may also be used to relieve ciliary spasm if reflex uveitis is present. Usually, one dose is enough.⁸

Epithelium regenerates faster than stroma. Occasionally, the epithelium completely covers the surface of the defect before the stroma has a chance to fill in. This defect is known as a *facet*. The ulcer will no longer be fluorescein positive because the surface epithelium is intact, but the area is still delicate due to the loss of stroma. No further treatment is indicated.



FIGURE 1. Descemetocoele in a 12-year-old German shepherd. This dog had a long history of pannus in both eyes that was being treated with twice-daily steroids and cyclosporine. It was also on systemic prednisone for a dermatologic condition. A corneal ulcer had been noted 3 weeks prior and became progressively deeper.

Descemetocoeles and Perforations

Ulcers that are as deep as Descemet's membrane are called descemetocoeles (**FIGURE 1**). If the ulcer penetrates Descemet's membrane, the cornea is perforated. Aqueous humor will leak out and the hole will become plugged by either the iris or a fibrin clot.

Descemetocoeles should ideally be treated surgically with the placement of a graft.⁹ If owners cannot afford surgery or the patient is not an ideal anesthetic candidate, aggressive medical management can be attempted with the knowledge that the eye may have to be removed (enucleated). Reasons for enucleation are graft dehiscence, corneal perforation under the graft, uncontrollable intraocular inflammation, and intraocular infection.

Perforated eyes may still be salvaged depending on the size and age of the perforation (**FIGURE 2**). If the eye



FIGURE 2. Ruptured cornea of less than 1 hour's duration in a 5-year-old Pekingese. An ulcer was noted 1 week prior.



FIGURE 3. A small intestinal submucosa graft used to treat corneal perforation in a 4-year-old pug. Small purple sutures can be seen at the periphery (**white arrow**).



still has a positive dazzle response, vision might be able to be saved. If the owners feel very strongly that they want to save the globe with or without vision, a graft can be attempted (**FIGURE 3**). Again, surgical intervention is the best chance at saving the globe, but owners should be made aware that the eye may still need to be enucleated or become phthisical (shrunken). If a watertight seal cannot be accomplished, the eye will continue to leak and be a source of pain and possible infection.

DISORDERS ASSOCIATED WITH CORNEAL ULCERATION

Entropion, or rolling in of the eyelids, can cause chronic corneal ulceration due to the haired skin constantly rubbing the delicate cornea. In young dogs that have not reached their adult head size, it is recommended to temporarily tack the eyelids,¹⁰ rolling them out and affixing with sutures so the hairs no longer rub the cornea (**FIGURE 4**). This may need to be repeated as the dog grows or scratches the sutures out. Once the dog has finished growing, permanent surgical correction should be performed.

If the entropion is secondary to fat loss or muscle wasting, such as in elderly or debilitated dogs, hyaluronic acid subdermal filler can be used. This procedure can be performed without general anesthesia. Resolution of corneal ulceration and epiphora should be seen within a week.¹¹

Abnormal eyelid hairs such as distichia and ectopic cilia can also cause chronic corneal ulceration (**FIGURE 5**).



FIGURE 4. Superficial ulcer in a 3-year-old English bulldog. The ulcer caused spastic entropion, requiring the eyelid to be temporarily tacked away from the cornea to allow the ulcer to heal.

Distichia are hairs that erupt from the meibomian gland openings along the eyelid margin. These hairs can be long and soft or short and stout. The long, soft hairs do not often cause corneal ulceration because they float in the tear film. The short, stout hairs can cause breaks in the epithelium if they poke the cornea. If it is unclear if distichia are the cause of an ulcer, they can be epilated. If the ulcer heals before the hairs regrow, permanent removal of the hairs should be recommended. Permanent removal can be accomplished in several ways. If only a few hairs are present, surgically excising the hair follicles is the standard procedure. If multiple distichia are present, electrocautery, cryotherapy, or laser therapy may be used to destroy the follicles.¹²

If a vertical oval ulcer is chronically present, ectopic cilia should be suspected. These hairs are harder to find as they emerge from the palpebral surface, or the conjunctival side of the eyelid. They occur most commonly on the upper lid. The cilia are often so small that magnification is needed to see them. Surgical excision is the most common method for removal of ectopic cilia.

Tumors of the eyelid may also cause corneal ulceration by constantly rubbing the cornea. Most canine eyelid masses are benign but continue to grow over time. Surgical removal is indicated when corneal health is in jeopardy. Masses that occupy one-third or more of the



FIGURE 5. Facet in a 14-year-old Shih Tzu. A corneal ulcer had been present for 2 weeks and eventually formed a descemetocele. Multiple distichia were discovered on the upper eyelid, along with an ectopic cilia that lined up exactly with the descemetocele. The owners elected to have the abnormal hairs removed and treat the cornea with medical management. The descemetocele epithelialized in 2 weeks, leaving the facet. Note that the only stain on the cornea is pooling in the facet.

eyelid margin should be referred to an ophthalmologist, as eyelid reconstruction may be needed.

ULCERS DUE TO CHRONIC CORNEAL EXPOSURE

Constant corneal exposure owing to an inability to blink the lids completely closed can lead to corneal ulcers (**FIGURE 6**). Brachycephalic dogs are more prone to corneal ulcers than breeds with other skull conformations as they are often exophthalmic (i.e., the eye bulges anteriorly out of the orbit) as well as lagophthalmic (i.e., they cannot completely close their eyelids). One study showed that brachycephalic dogs are 20 times more likely than nonbrachycephalic dogs to get corneal ulcers and that corneal ulcers are most commonly diagnosed in pugs.¹³ A medial canthoplasty may be recommended for dogs with severe breed-related exophthalmia or lagophthalmos. This is a surgical procedure in which the lengths of both the upper and lower eyelids are shortened, reducing the amount of globe exposed.

Other breeds of dogs may become exophthalmic owing to retrobulbar space-occupying lesions. The cause of exophthalmia should be worked up, as there are many differentials. These dogs should have the cornea lubricated often to avoid drying of the cornea and subsequent corneal ulceration until the exophthalmia has resolved.



FIGURE 6. Melting corneal ulcer in a 9-year-old pug. The owners had noticed a bubble on the eye 4 days before presentation to their general practice veterinarian; they had noted the eye was cloudy 4 days prior to that. The veterinarian debrided the lesion and prescribed tobramycin. An E-collar was not used. The dog began rubbing the eye and was then referred with a melting corneal ulcer. The cornea perforated within the first 24 hours of hospitalization, and the eye was enucleated.

Glaucoma or intraocular masses may cause enlargement of the globe itself (i.e., buphthalmia). Some dogs with these conditions become so buphthalmic that they are unable to blink their eyelids completely over the cornea. These dogs should also have the cornea frequently lubricated. It is also recommended that an end-stage procedure, such as enucleation or intravitreal injection of gentamicin or cidofovir, be performed.¹⁴

Facial nerve paralysis is another cause of chronic corneal exposure. Dogs with facial nerve paralysis may also have decreased tear production and loss of or diminished corneal sensation. All of these can lead to corneal ulcers. Again, frequent corneal lubrication is recommended.¹⁵ A temporary or permanent tarsorrhaphy may be recommended as well.¹⁶ A *tarsorrhaphy* is a surgical procedure in which the eyelids are partially sutured together to narrow the eyelid opening, thereby exposing less cornea.

Corneal ulcers resulting from chronic exposure should be treated with a prophylactic topical antibiotic along with frequent corneal lubrication. An E-collar should also be placed until the ulcer is healed. If the chronic corneal exposure is breed related, a topical lubricant should be recommended for life. If the eye is severely exophthalmic or lubrication is not enough to protect the cornea, then a procedure to reduce exposure, such as a canthoplasty, can be performed.

ULCERS DUE TO TEAR FILM ABNORMALITIES

Qualitative and quantitative tear deficiencies can both contribute to canine corneal ulcers. Quantitative tear deficiency, better known as keratoconjunctivitis sicca (KCS), is more commonly recognized than qualitative tear deficiency.

Dogs that present with a corneal ulcer should have a Schirmer tear test performed unless the ulcer is deep or the dog has significant epiphora. Schirmer tear test I is the most common tear test in veterinary medicine. For this test, a small strip of paper is bent and the end placed between the lower eyelid and the nonanesthetized cornea for one minute. The test measures the amount of basal and reflexive tears produced as the length of the strip that becomes wet in 1 minute. A normal Schirmer tear test result is 15 mm or greater in 1 minute.¹ Less than 15 mm/min could indicate “dry eye.”



Approximately 75% of SCCEDs heal after the first diamond burr debridement with an appropriate aftercare treatment plan.²⁰



Corneal ulcers in dogs with KCS can become serious very quickly due to the lack of tears and poor corneal health. These patients should be treated with an artificial tear ointment or other lubricant as well as prophylactic topical antibiotics. Tear stimulants should be used for at least 3 months to determine if they are increasing tear production. Owners often think that they should see improvement by the time the first tube/bottle of medication runs out in approximately 6 weeks. Dogs with chronic KCS are more resistant to ulceration because the cornea becomes toughened by long-term changes like pigment and fibrosis.

Dogs presenting with chronic nonhealing ulcers with no loose epithelial edges should have a tear film breakup time (TFBUT) test performed. Mucin deficiency is a form of qualitative tear deficiency that allows the tears to evaporate more quickly and leads to drying of the cornea. The TFBUT test is performed by instilling fluorescein stain onto the cornea, blinking the eyelids to completely cover the surface of the cornea, and then counting the seconds from opening the eyelids until the first dry spot or break up in the tear film is seen. Normal TFBUT in the dog is 20 seconds or longer.¹⁷ Dogs with mucin deficiency should be treated with an artificial tear gel (mucinomimetic). While an ulcer is present, they should also be treated with prophylactic topical antibiotics and placed in an E-collar.

SPONTANEOUS CHRONIC CORNEAL EPITHELIAL DEFECT

Indolent ulcer and *Boxer ulcer* are common names for spontaneous chronic corneal epithelial defect (SCCED). In these patients, a hyalinized membrane forms over the stroma, preventing epithelial cells from adhering and the ulcer from healing. To allow epithelial cells to adhere, the membrane must be debrided or perforated. These ulcers can be frustrating to treat until

they are correctly diagnosed. They will not heal without mechanical intervention.

Patients with an SCCED are middle-aged to older dogs and present with a chronic superficial ulcer. Upon close examination, a loose edge of epithelium can be seen around the ulcer. A dry cotton-tipped swab can be rubbed over the edge of the ulcer to confirm that the edge is loose. SCCEDs are treated by mechanical debridement of the loose edges and roughening of the underlying stroma. This can be accomplished using a few different techniques. Two studies have shown that there is no statistical difference in healing between the 2 most common methods: diamond burr debridement and grid keratotomy.^{18,19} In rare instances, both diamond burr debridement and grid keratotomy fail, and a superficial keratectomy must be performed under a surgical microscope to fully debride the corneal surface.

Not all SCCEDs heal the first time they are debrided. Some may take 2 or 3 debridements. The key is making the owners leave an E-collar on the patient until the ulcer is healed. The epithelial cells adjacent to the defect are already poorly attached, and rubbing the eye before it is completely healed will wipe away the newly laid cells.

Approximately 75% of SCCEDs heal after the first diamond burr debridement with an appropriate aftercare treatment plan.²⁰ Many different treatment plans have been suggested. In the author's practice, the patient is treated after diamond burr debridement with the placement of a soft contact bandage lens,²¹ an E-collar, topical antibiotics, and oral NSAIDs. Post-debridement treatment should continue for 2 weeks before reexamination. Owners should be counseled that once a dog has had an SCCED, it is far more likely to have another. Boxers are 2.3 times more likely than other breeds to have a subsequent SCCED in the contralateral eye within 24 months.²⁰

CLIENT EDUCATION

Superficial uncomplicated ulcers should be rechecked in approximately 1 week to confirm that the cornea has healed. During that week, clients should be instructed to watch for increased discomfort, yellow or green mucoid discharge, and color changes as described earlier, particularly a yellow or green color to the cornea. These are all signs that the ulcer is becoming worse instead of better. Clients should understand that topical antibiotics are prophylactic and should be used

as prescribed, typically 4 times a day. Not doing so could cause antibiotic resistance if the cornea were to become infected.

Clients should also understand the importance of a properly fitted hard plastic E-collar. Rubbing the eye (e.g., with a paw, on the floor, on furniture) or licking of the ocular surface by other pets will impede the healing process. Soft fabric E-collars, donut-type collars, and neck brace-type collars will not prevent these activities.

Infected, stromal, and melting ulcers should be examined more frequently than once a week, ideally every 48 to 72 hours. A corneal cytology sample should be carefully obtained and evaluated at each visit to determine if the bacterial and/or neutrophil load is increasing or decreasing. Again, owners should be aware of the importance of giving topical antibiotics and anticollagenase as prescribed and keeping the E-collar on. These patients may also need stronger treatment for pain relief.

Patients with an SCCED should be given 10 to 14 days to try to heal before reexamination. If the patient does not heal after being debrided twice by the primary care veterinarian, an ophthalmology referral should be offered. The importance of keeping a properly fitted E-collar on these patients cannot be stressed enough to owners. Debridement and an E-collar are the keys to getting SCCEDs to heal.

Boxers and bulldogs commonly produce granulation tissue on their cornea as they heal. Owners are often overly concerned as they see blood vessels and pink tissue growing into the cornea and commonly call because they believe the eye is getting worse and bleeding. With the technology available to most clients today, they can take a photograph of the eye and email or text it to the clinic. Most cell phones take photographs of high enough quality to determine if the eye is in danger or healing with granulation tissue. Photographs do not replace an in-person ocular examination but can often prevent an unnecessary emergency visit. **TVN**

Suggested Reading

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CONTINUING EDUCATION

Managing Canine Corneal Ulcers

TOPIC OVERVIEW

Corneal ulceration, or a break in the corneal epithelium, can have a variety of causes. Common etiologies include trauma, entropion, ocular foreign bodies, and dry eye disease. Ulcers are commonly classified by the depth of corneal involvement and by cause. This article reviews corneal anatomy and physiology, basic classifications of corneal ulcers, what owners need to know about caring for dogs with ulcers, and monitoring and rechecking patients with corneal ulcers.

LEARNING OBJECTIVES

After reading this article, participants will be able to recognize different classifications of ulcers and identify the underlying cause and/or complicating factors. They will also be able to explain the treatment of spontaneous chronic corneal epithelial defects to owners.

The article you have read has been submitted for **RACE approval for 1 hour of continuing education credit** and will be opened for enrollment when approval has been received. To receive credit, take the approved test online for free at [vetfolio.com/journal-ce](https://www.vetfolio.com/journal-ce). Free registration on [VetFolio.com](https://www.vetfolio.com) is required. Questions and answers online may differ from those below. Tests are typically valid for 2 years from the date of approval.

- 1. An uncomplicated ulcer should heal in _____ days.**
 - a. 3 to 5
 - b. 5 to 7
 - c. 7 to 10
 - d. 10 to 14
- 2. The stroma is**
 - a. Hydrophilic
 - b. Hydrophobic
 - c. Composed of blood vessels
 - d. A single cell layer
- 3. Distichia are hairs that erupt from the**
 - a. Palpebral conjunctiva
 - b. Tarsal glands
 - c. Meibomian glands
 - d. Sebaceous glands
- 4. What is the purpose of a medial canthoplasty?**
 - a. To improve the patient's eyesight
 - b. To remove excess fat deposits
 - c. To roll the eyelids out
 - d. To shorten the eyelid opening
- 5. Dogs with facial nerve paralysis could benefit from**
 - a. Tarsorrhaphy
 - b. Atropine
 - c. Ethylenediaminetetraacetic acid
 - d. Medial canthoplasty
- 6. Which test is used to confirm qualitative tear film deficiency?**
 - a. Schirmer tear test
 - b. Fluorescein stain
 - c. Tear film break up time
 - d. Rose bengal stain
- 7. The mucin layer of the tear film is responsible for**
 - a. Nourishing the cornea
 - b. Lubricating the eye
 - c. Preventing infection
 - d. Allowing the aqueous layer to spread evenly and stick to the surface of the cornea
- 8. At what rate do vessels grow into the cornea?**
 - a. 1 mm/hour
 - b. 3 mm/hour
 - c. 1 mm/day
 - d. 3 mm/day
- 9. A spontaneous chronic corneal epithelial defect (SCCED) should heal in _____ after debridement.**
 - a. 1 week
 - b. 2 weeks
 - c. 1 month
 - d. 2 months
- 10. A small, flattened depression on the outer surface of the cornea due to a healed ulcer that has failed to fill with stroma is a(n)**
 - a. Abscess
 - b. Bulla
 - c. Facet
 - d. Scar