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# MELTING CORNEAL ULCER MANAGEMENT IN A GREATER ONE-HORNED RHINOCEROS (*RHINOCEROS UNICORNIS*)

**A. Rae Gandolf, D.V.M., A. Michelle Willis, D.V.M., Evan S. Blumer, V.M.D., and Mark W. Atkinson, B.V.Sc.**

*Abstract:* Acute unilateral keratomalacia, probably secondary to trauma, occurred in a greater one-horned rhinoceros (*Rhinoceros unicornis*) transferred between zoologic facilities. Following 2 days of medical treatment, a 360° conjunctival surgical graft was performed. *Staphylococcus* and yeast were isolated from a perioperative culture of the affected eye and were treated with antimicrobials. There was rapid healing and minimal midcorneal scar formation with peripheral corneal clarity.

*Key words: Rhinoceros unicornis,* rhinoceros, keratomalacia, corneal ulcer, conjunctival graft, veterinary ophthalmology.

## INTRODUCTION

Keratomalacia has been reported in companion animal species, often following corneal trauma,[11,16] but little information exists on corneal disease in captive nondomestic mammals.

## CASE REPORT

A 19-mo-old male greater one-horned rhinoceros (*Rhinoceros unicornis*), born and raised at the National Zoo in Washington, D.C., was relocated to The Wilds in Cumberland, Ohio. The rhinoceros had previously been crate-trained in preparation for transport, so chemical sedation was not used. After loading into a wooden crate, the animal became excited and forced his head upward and through the crate ceiling. Minor superficial dermal lesions about the head were observed when the rhinoceros was released from the crate. Etorphine hydrochloride (M99-Ten®, Wildlife Pharmaceuticals, Fort Collins, Colorado 80524, USA; 1 mg i.m.) was remotely administered for sedation and subsequent reloading into a different crate. The following 10 hr of transport and off-loading were uneventful. Approximately 48 hr after shipping, an opacity involving 60% of the corneal surface of the left eye was identified. Twenty-four hours after initial observation of the lesion, the opacity had progressed to a "dripping" appearance, sometimes referred as "hydrops" cornea or keratomalacia, involving approximately 80% of the cornea (Fig. 1).

No initial blepharospasm was evident in the left eye, although there was mild epiphora and rubbing of the left side of the head. A topical ophthalmic solution including equal volumes of saline wash, gentamicin sulfate (Gentaject® 100 mg/ml, Vetus Animal Health, Anthony Products Co., Arcadia, California 91006, USA), and 1% atropine sulfate (E. Fougera & Co., Melville, New York 11747, USA) was administered to the left eye every 2–4 hr, and sulfamethoxazole/trimethoprim (800 mg trimethoprim/160 mg sulfamethoxazole USP tablets, Mutual Pharmaceutical Co., Philadelphia, Pennsylvania 19124, USA; 30 mg/kg s.i.d.) was adminstered orally. Topical medications were administered using 1-ml syringes with 25-ga needles broken off at the hubs so that that the medications could be sprayed over the ocular surface. Because of rapid progression of the lesion over 24 hr, 0.2 ml topical therapy was changed to ciprofloxacin HCl (Ciloxan®, Alcon Laboratories, Fort Worth, Texas 76134, USA; every 2 hr), 0.2 ml topical autogenous serum application every 2 hr as anticollagenase therapy (using blood collected during ophthalmic exam), and 0.2-ml topical atropine t.i.d. Oral therapy with flunixin meglumine granules (Banamine®, Schering Corp., Kenilworth, New Jersey 07033, USA; 1 g s.i.d.) was also initiated.

A general ophthalmic examination was performed under sedation following remote delivery of etorphine hydrochloride (0.5 mg i.m.) and detomidine HCl (Dormosedan®, Pfizer, Exton, Pennsylvania 19380, USA; 8 mg i.m.). The left eye had keratomalacia involving 80% of the cornea and peripheral neovascularization but no fluorescein uptake. The right eye had a 1- × 2-mm superficial ulcer in the temporolateral aspect of the cornea. Swabs of the ulcer were taken for bacterial culture and sensitivity, and penicillin procaine G (Aquacillin®, Vedco, St. Joseph, Missouri 64504, USA; 0.5 ml) and gentamicin sulfate (0.5 ml) were injected subconjunctivally. Topical ciprifloxacin was applied to both eyes, and blood was collected for topical serum application. The narcotization was antagonized with diprenorphine HCl 0.2% (M50/50®,

From The Wilds, 14000 International Road, Cumberland, Ohio 43732, USA; and the Ohio State University Veterinary Teaching Hospital, Vernon L. Tharp Street, Columbus, Ohio 43210, USA.

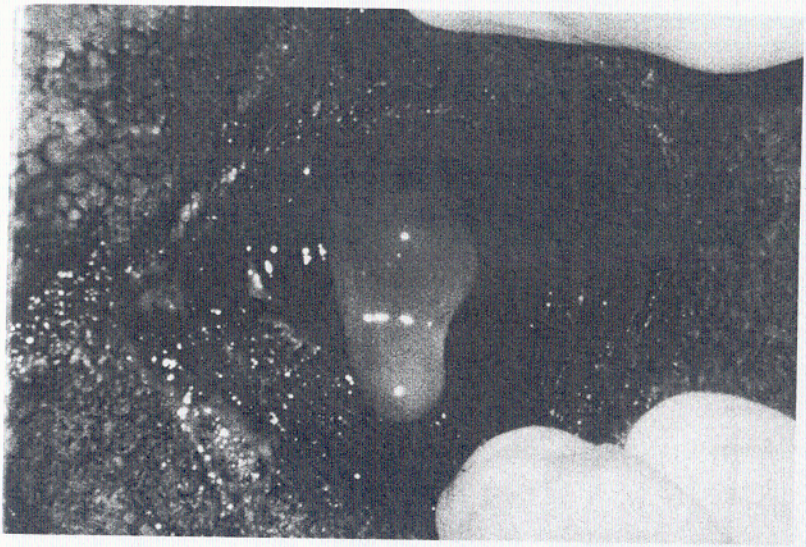

**Figure 1.** Left eye of a 19-mo-old male greater one-horned rhinoceros (*Rhinoceros unicornis*) at the time of initial ophthalmic exam 48 hr after transport and suspected corneal trauma.

Lemmon Co., Sellersville, Pennsylvania 18960, USA; 2 mg, 50% s.c. and 50% i.v.). Diprenorphine was used because of its relatively short half-life; repeat anesthesia was anticipated within 48 hr. Recovery was uneventful.

The left eye lesion continued to worsen after 48 hr of medical therapy, so the patient was immobilized with etorphine HCl (8 mg i.m.) and detomidine HCl (10 mg i.m.) for examination and surgery. Under slit lamp examination, the left eye showed keratomalacia involving 80% of the central cornea, 2 mm of clear corneal periphery, 360° 2-mm corneal neovascularization, mild anterior uveitis, and bulbar conjunctival hyperemia. A 2-mm temporolateral corneal erosion was present in the right eye with associated 1-mm corneal neovascularization extending from the dorsal limbus. The possibility of corneal scarring associated with stromal healing provided a guarded prognosis for sight in the left eye, and surgery was chosen to provide rapid resolution of the keratomalacia and return of ocular comfort.

The diseased cornea was debrided, and a 360° conjunctival graft was advanced.[10,16] Samples of debrided cornea were collected for histopathology, fungal culture, and aerobic bacterial culture and sensitivity. An incision was made through the bulbar conjunctiva 3 mm posterior to the limbus, avoiding tenon's capsule where the conjunctiva is tightly adhered, beginning dorsally, and extending around the cornea. The conjunctiva was undermined with tenotomy scissors to the level of the fornix centripetally along the incision. Tension relieving sutures were placed through the graft conjunctiva and bulbar conjunctiva at the dorsal and ventral limbus (at approximately 11, 1, 5, and 7 o'clock) to anchor the graft to the sclera in the most critical central portion of the cornea. Dorsal and ventral conjunctival margins were then advanced over the central cornea and apposed using 6-0 vicryl simple interrupted closure and oversewn with a simple continuous pattern, creating a horizontal suture line. The result was complete corneal coverage overlapped by the nictitating membrane medially (Fig. 2). Narcotic sedation was antagonized with 150 mg naltrexone (Trexonil®, Wildlife Pharmaceuticals; 75% i.v. and 25% s.c.) Recumbency for examination and surgery lasted 78 min. Recovery was uneventful, and there was no evidence of postoperative discomfort.

Topical atropine was applied postoperatively

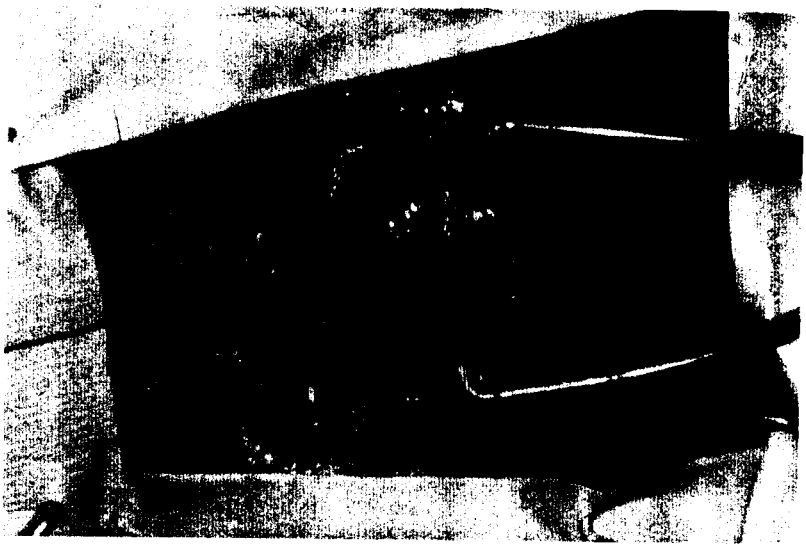

**Figure 2.** Left eye of a 19-mo-old male greater one-horned rhinoceros (*Rhinoceros unicornis*) immediately after conjunctival graft surgery for management of progressive keratomalacia.

q.i.d. for 2 days; flunixin meglumine was administered 1 g p.o. s.i.d. for 2 wk, and topical ciprofloxacin HCl solution was applied q.i.d. for 2 wk. Stall confinement was maintained for 3 wk to reduce the potential for additional eye trauma. The rhinoceros tolerated treatment and exhibited occasional rubbing as the only sign of discomfort.

Cultures yielded *Staphylococcus* sp. and low numbers of unidentified yeast. Based on sensitivities, treatment was continued with topical ciprofloxacin HCl, and topical 1% miconazole (Monistat I.V.®, Janssen Pharmaceuticals, St. Joseph, Missouri 64504, USA; t.i.d. for 2 wk) therapy was initiated. Histopathologically, the debrided cornea revealed completely necrotic tissue with no identified etiology that was compatible with trauma. Cellular detail, however, could not be evaluated.

Eight days postoperatively, a 3- × 3-mm dark purple-gray area of comparatively thin conjunctiva was observed in the lateral paraxial region of the conjunctival graft suture line. Possible causes included suture dehiscence and tissue necrosis. This area increased to approximately 7 × 7 mm in size 11 days postoperatively, and relatively clear cornea was observed laterally through this dehiscence in the suture line (Fig. 3). The lateral separation was roughly 10 mm in diameter 14 days postoperatively and did not progress further.

The eyes were reevaluated and the conjunctival graft was trimmed 6 wk postoperatively following immobilization with 0.8 mg etorphine HCl and 8 mg detomidine HCl administered via i.m. dart injection. The conjunctival graft was adhered appropriately to the central cornea, and the medial and lateral aspects of the graft had retracted toward the limbus. The intact conjunctiva was cut along the level of the limbus and excess central conjunctiva, which had become pigmented, was trimmed from the central cornea. Narcotic antagonism with 100 mg naltrexone was uneventful.

The result of therapy as seen 6 wk postoperatively was a salvaged globe characterized by an opaque scar involving 60% of the central corneal surface (Fig. 4). The graft had undergone further corneal integration 6 mo postoperatively, leaving a minimal scar and apparently improved vision.

## DISCUSSION

Corneal insult can induce significant inflammatory response with rapidly progressive stromal col-

**Figure 3.** Left eye of a 19-mo-old male greater one-horned rhinoceros (*Rhinoceros unicornis*) 11 days postoperatively. Minimal conjunctival graft dehiscence along the lateral aspect of the suture line is apparent. Superficial epidermal erosion associated with self-trauma is evident ventral to the eye.

lagenolysis, with or without bacterial infection.[6,10,12] Despite aggressive treatment, keratomalacia can lead to perforation, iris prolapse, and endophthalmitis within 24–48 hr and eventually to phthisis bulbi.[12,17] In horses, keratomalacia is most commonly seen in association with posttraumatic opportunistic bacterial infection,[17] and this condition has not been documented previously in rhinoceros.

In the present case, the lesion was probably induced by trauma, as evidenced by the corneal ulceration in the right eye, superficial abrasions on the head, and the temporal relationship of the disease and transport.

Medical therapy began empirically and continued based on test results. A course of systemic antibiotics was completed because of the threat of globe perforation. Initial subconjunctival treatment was begun because the feasibility of topical therapy was in doubt.[10] When the corneal epithelial barrier has been significantly damaged, similar corneal drug concentrations can be achieved using subconjunctival and topical routes.[10]

Alpha-2 macroglobulins and lysosomal inhibitor in serum have anticollagenolytic properties, so autogenous serum may be a readily available anticollagenase treatment if it can be collected.[3,6] Other options that may be useful for anticollagenase treatment include cysteine, acetylcysteine, sodium-tetraacetate, and heparin.[6]

To reduce pain associated with ciliary contraction resulting from keratomalacia and anterior uveitis, topical atropine was used for dilation of the pupil and relief of iridociliary muscle spasm.[6] Systemic banamine was also used to control prostaglandin-mediated intraocular pain and inflammation.[6]

The equine eye represents the closest model to the rhinoceros eye for which significant ocular surface floral research has been performed. *Staphylococcus* sp., *Streptococcus* sp., *Bacillus cereus*, and *Corynebacterium* sp. are among the most frequently isolated healthy equine corneal bacteria,[12,21] and *Staphylococcus* sp., *Streptococcus* sp., *Pseudomonas* sp., *Enterobacter* sp., and *Acinetobacter* sp. are commonly isolated from equine eyes with external ocular disease.[2,6,12,21,22] Although fungal organisms, particularly *Aspergillus* sp.,[14,15,20] can be pathogenic, they are also commonly isolated from healthy equine eyes.[12,20] Normal flora may vary with geo-

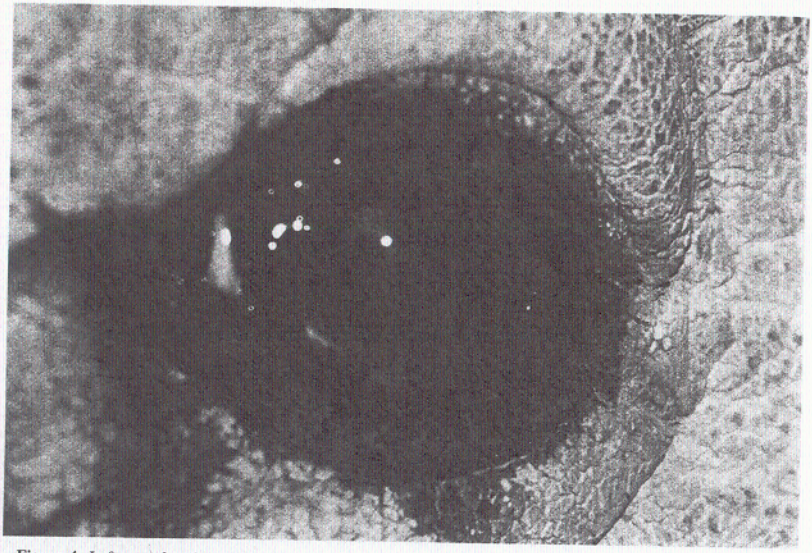

**Figure 4.** Left eye of a 19-mo-old male greater one-horned rhinoceros (*Rhinoceros unicornis*) approximately 6 mo postoperatively. A minimal axial corneal scar is apparent.

graphic location and husbandry practice.[17,22] The malaciac cornea overhanging a contaminated lid margin is a potential source of further contamination. Because both *Staphylococcus* sp. and yeast, the positive isolates in this case, are common in barns and may be normal rhinoceros flora, the opposite eye could have been cultured for comparison. Because the isolates were potential pathogens and the normal ocular flora of rhinoceros is unknown, the bacteria were treated with antimicrobials based on sensitivities.

Although damaged, the epithelial barrier may still exist in malaciac ulcers. Broad-spectrum activity and ability to penetrate corneal epithelium are essential properties for topical ophthalmic antimicrobial preparations. Ciprofloxacin HCl has superior corneal penetration and broad-spectrum activity and was therefore initiated pending antibiotic susceptibility results.[5,14]

Natamycin (Natacyn, Alcon Laboratories) and miconazole are efficacious and frequently used topical ophthalmic antifungal agents.[6,16] Silver sulfadiazine cream (Silvadene cream 1%, Hoechst Marion Roussel, Kansas City, Missouri 64137, USA) may provide effective topical antifungal/antibacterial action and could be useful when other treatments are not available.[13,16] Fungal sensitivity was not pursued because of time constraints.

Surgical therapy is indicated when more than half of the depth of the corneal stroma has been lost.[10] Conjunctival grafting provides blood supply with neutrophils, humoral immune components, antibiotics, and serum enzymes to the injury[1,17] as well as pain relief and physical protection.[1,10,18] In human and veterinary medicine, conjunctival grafting is often the method of choice for treating deep ulcers.[7,8,16,17,19] Although corneal transplants can provide a virtually scarless cornea in humans,[11] even autogenous corneal transplants in nonhuman species opacify to some extent[4,6] and provide little advantage over conjunctival grafts.

Disadvantages of the 360° conjunctival graft include inability to assess cornea and anterior uvea, temporary impairment of patient vision, and interference with topical medication absorption until the graft is trimmed (4–6 wk).[17,23] Potential postsurgical complications include perforation under the graft and failed apposition of the graft and recipient tissue.[23]

Although there are numerous methods for conjunctival grafting,[10,18] the 360° flap method was cho-

sen because it requires the shortest surgery and anesthesia time without suturing through fragile cornea, and it provides a large coverage area. Duration of anesthesia is especially important in large animals prone to lung compromise and nerve paralysis associated with recumbency and because tracheal intubation is problematic.

Initial removal of necrotic cornea helps end collagenolysis regardless of whether grafting is pursued and can be accomplished with topical anesthetic, palpebral nerve blocks, and scissors before a decision on surgical intervention is required.

Although corneal epithelium is replaced via migration and mitosis of cells, stromal cells do not regenerate and are replaced by scar tissue.[6,16] Once established, scar tissue typically contracts, leaving more organized and vision-bearing cornea along the periphery after several months.[3] In a zoologic setting, both patient vision and appearance may be important, and although rhinoceros are believed to be myopic, mild hyperopia has been demonstrated in four rhinoceros examined by retinoscopy and infrared photorefraction.[9] Therefore, in spite of a central corneal scar, retention of corneal stromal clarity in a significant portion of the paraxial and peripheral cornea may be functionally important.

Rhinoceros and other nondomestic hoofstock are among the animals most susceptible to corneal trauma, given their typically large and laterally placed globes and intractable nature. This case demonstrates that ophthalmic techniques used in domestic species may be applied to nondomestic species such as the rhinoceros. Surgical therapy helped salvage the eye in this animal and should be considered to help resolve any deep or progressive case of keratomalacia. A high degree of patient compliance with medical therapy was also important in this case, but facilities must be equipped to provide necessary veterinary management. The three required immobilizations added risk and expense to therapy, and such risks must be weighed against the potential benefit of treatment.

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