CASE REPORT

Surgical management of a malacic corneal ulcer in a greater one-horned Asian rhinoceros (*Rhinoceros unicornis*) using a free island tarsoconjunctival graft

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Abstract

A greater one-horned Asian rhinoceros (*Rhinoceros unicornis*) presented for presumed ocular trauma to the left eye, with secondary bacterial infection, resulting in severe and progressive corneal ulceration. Following a poor response to medical therapy, the animal was anesthetized for further examination, and a bulbar conjunctival pedicle graft performed. This graft failed by 48-h postsurgery as a result of self-trauma. The animal was re-anesthetized, and a free island tarsoconjunctival graft performed. This second procedure was successful, resulting in globe preservation, cosmesis, and functional vision in the affected eye.

Key Words: Asian rhinoceros, island, tarsoconjunctival graft

INTRODUCTION

Management of corneal injury in large nondomestic animals presents unusual challenges to the practitioner. The rhinoceros is a megavertebrate species that presents special concerns in regard to ophthalmic examination, anesthesia, and postoperative management. This report describes the successful management of a deep corneal ulcer in a greater one-horned Asian rhinoceros (*Rhinoceros unicornis*) using a free island tarsoconjunctival graft.

CASE REPORT

A 34-year-old male greater one-horned rhinoceros was maintained in a spacious, natural enclosure at a captive breeding facility along with a single female. Initial signs noted by keepers included mild general lethargy as well as blepharospasm, an area of corneal opacity, and an area of presumed corneal ulceration affecting the left eye. It was possible to intermittently medicate the eye topically after enticing the animal with favorite foods, and the animal was started on a treatment regime consisting of topical cefazolin sodium (West-Ward Pharmaceutical Corp, Eatontown, NJ, USA), reconstituted in ophthalmic saline to a concentration of 50 mg/mL, OS, q4 h; topical tobramycin ointment (Alcon Laboratories, Fort Worth, TX, USA) OS, q4 h; topical natamycin (Alcon Laboratories), OS, q3 h; topical 1% atro-

pine (Miza Pharmaceuticals, USA, Inc., Fairton, NJ, USA), OS, q12 h; and oral phenylbutazone at 2 g PO q24 h × 5 days (First Priority, Inc., Elgin, IL, USA).

In spite of treatment, the blepharospasm failed to resolve and the area of corneal opacity increased in size over the ensuing 48 h. Based on the apparent progression of clinical signs, it was decided to anesthetize the animal in order to perform an ocular examination and possible surgery. The rhinoceros was immobilized by darting with 3.8 mg of etorphine (ZooPharm, Laramie, WY, USA), 20 mg of detomidine (Pfizer Animal Health, Exton, PA, USA), and 100 mg of ketamine (Phoenix Scientific, Inc., St Joseph, MO, USA). Supplemental ketamine, detomidine, and guaifenesin (Phoenix Scientific, St Joseph, MO, USA) were administered intravenously over the course of the immobilization. Supplemental oxygen was provided nasally. A blood sample was collected for a complete blood cell count (CBC) and serum biochemical panel, and all results were within normal limits.[1] Blood was also collected for the preparation of autogenous serum to be used as a topical anticollagenase agent.

Ocular examination was intentionally brief based on the anesthetic risk in this animal. No lid abnormalities or foreign bodies were noted. Schirmer tear testing was not performed. Intraocular pressure (IOP) in the affected eye was 10 mmHg, recorded by handheld applanation tonometer (Tonopen, Mentor, Santa Barbara, CA, USA), which is significantly

Figure 1. Appearance of corneal ulceration following 48 h of medical therapy.

Figure 3. Immediate postoperative appearance of the free island tarsoconjunctival graft.
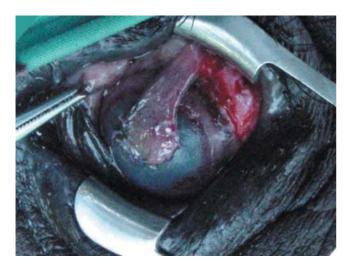

Figure 2. Immediate postoperative appearance of the conjunctival pedicle graft.

Figure 4. Appearance of the cornea 6 months postoperatively.

lower than that reported in the most closely related species for which data were available, the white rhinoceros (*Ceratotherium simium*) (32.1 ± 10.4 mmHg).[2] It was not possible to access the right eye for IOP measurement.

Slit-lamp examination revealed generalized corneal edema, a dense peripheral (360°) vascular fringe, a central area of ulceration that was approximately 2/3 stromal thickness and malacic in appearance, and moderate anterior chamber aqueous flare (Fig. 1). Corneal scrapings for cytology and swabs for bacteriological investigation, as well as a small conjunctival sample for herpesvirus polymerase chain reaction (PCR) were collected.

Fluorescein staining of the defect was positive with the exception of a small central area, consistent with a descemetocele. Fundic examination was not performed. Based on the depth and progression of the lesion, it was decided to perform a surgical repair, using a conjunctival pedicle graft, in

order to provide a vascular supply as well as tectonic support to the affected area.

The eyelids were retracted using a wire eyelid speculum, and the fornices and cornea lavaged with a dilute (5%) solution of povidone iodine. Loose epithelium and devitalized tissue was debrided from the defect using sterile cotton-tipped applicators. A pedicle conjunctival graft was fashioned from the dorsolateral bulbar conjunctiva and rotated to cover the defect. The pedicle was free from tension and slightly larger than the diameter of the defect. After being trimmed to size, the pedicle was sutured into the defect using interrupted, absorbable, 6-0 sutures (Vicryl, Ethicon Inc., Somerville, NJ, USA). A single tension-relieving suture was also placed on either side of the pedicle base[3] (Fig. 2). Following pedicle placement, a drop of atropine was applied to the cornea and a subconjunctival injection of 0.2-mL gentamicin (Gentocin, 50 mg/mL, Schering-Plough, Kenilworth, NJ, USA) was administered. An equine, two-hole, subpalpebral lavage system

was placed in the superior fornix and sutured to the skin of the rostrum in the hope that topical therapy could be applied via the system when the animal was enticed with favorite foods.[4]

It was decided not to perform a temporary tarsoraphy on the grounds that this large and intractable animal's reaction to having its eyelids sewn closed could not be predicted, that it was not possible to confine or immobilize the animal or protect the globe postoperatively, and further, that a tarsorraphy would probably necessitate an additional anesthesia to remove the sutures. The etorphine and detomidine were reversed with 350-mg naltrexone (IV, ZooPharm, Fort Collins, CO, USA) and 10-mg atipamezole, IV (Pfizer Animal Health, Exton, PA, USA).

Treatment with cefazolin, tobramycin, and natamycin was increased to q3 h, and treatment with serum (OS, q3 h) was initiated. Soon after recovery, the animal was noted to be rubbing its left eye against a tree, presumably placing tension onto the graft via its pedicle attachment. By 2–3 h postoperation, the subpalpebral lavage catheter had been removed, and the pedicle was noted to have been abraded free from the cornea approximately 48 h following surgery.

Following lengthy discussion regarding the risks of repeat anesthesia, it was decided to place a free island tarsoconjunctival graft into the defect in the hope that its low profile, relative to the cornea, and absence of an attached pedicle would make this type of graft more difficult to traumatize. Despite the disappointing experience with the pedicle graft, it was still not deemed logistically feasible to protect the eye or immobilize the animal postoperatively using a protective cup or collar, nor ideal to perform a postoperative tarsorrhaphy for reasons already noted.

The animal was anesthetized in the same manner as described previously, the eyelids were retracted using a wire speculum and the cornea and fornix prepared using a 5% solution of povidone iodine. The defect was again superficially debrided using sterile cotton-tipped applicators. The upper eyelid was everted, and a 6500 surgical blade (Swann-Morton, Sheffield, UK) used to incise a roughly 15-mm circular area of conjunctiva and underlying substantia propria. This tissue was separated using Stevens tenotomy scissors and positioned on the cornea, trimmed to size, and seated into the corneal defect so that its margins apposed the edges of the defect and did not extend above the level of the surrounding cornea. The graft was sutured into position using interrupted 6-0 absorbable sutures (Vicryl)[5] (Fig. 3). A repeat subconjunctival injection of gentamicin was administered as before, but the subpalpebral lavage catheter was not replaced. The anesthesia was reversed, and recovery was uneventful. The animal exhibited a very limited amount of rubbing at the eyelids over the following 48 h but did not appear to abrade the cornea.

The corneal cytology revealed a neutrophilic inflammation with intracellular bacteria present. Treatment with natamycin was discontinued in the absence of demonstrable fungal organisms. Fungal culture results, which yielded scant growth of *Acremonium* sp., were not reported for several weeks, by which time there had been significant clinical improvement without additional antifungal therapy. Additionally, consensus nested PCR failed to identify the presence of any herpesvirus.[6] Bacterial culture yielded a moderate growth of *Aeromonas hydrophila* that was resistant to cephalosporins and sensitive to gentamicin. Cefazolin and tobramycin were discontinued and topical therapy with gentamicin (OS, q6 h) was initiated.

The graft became grayish/white and blanched in appearance by the third postoperative day. Ocular discharge was markedly reduced but still present for 10 days postoperatively, and a repeat conjunctival swab was obtained without sedation at this time for further bacteriology. Results from this sample yielded growth of *Providencia rettgeri* and coagulase-negative *Staphylococcus* sp. *P. rettgeri* was only intermediately sensitive to gentamicin, so gentamicin was discontinued and based on sensitivity, topical ofloxacin (Ocuflox, Falcon, Fort Worth, TX, USA) was initiated and maintained OS, for 1 week.

The graft was noted to be pink (vascularized) by day 21 following surgery. A small amount of contraction was noted within a week of vascularization, after which peripheral pigmentation of the graft was noted. The eye remained comfortable and functionally visual at follow-up 6 months postoperatively at which time a central corneal scar marked the site of prior ulceration (Fig. 4).

DISCUSSION

The handling and husbandry challenges presented by large nondomestic animals in captive environments may result in ocular trauma. Deep stromal ulcers, descemetoceles, corneal perforation, and some cases of stromalysis may require surgical intervention in order to preserve the eye.[7–9] Reported surgical techniques for the repair of deep corneal ulceration include tarsorrhaphy, third eyelid flap, corneoscleral advancement flaps, bulbar pedicle conjunctival grafts, free island tarsoconjunctival grafts and penetrating allografts, and autografts of corneal and corneoscleral tissues.[8–10] As this animal was part of an endangered species breeding program, it was felt important to attempt to preserve vision in order to maximize chances of natural mating behavior.

The surgical management of a melting corneal ulcer in a greater one-horned rhinoceros has been previously reported using a 360° conjunctival advancement graft.[11] Although globe salvage was achieved using the 360° graft, this technique may offer reduced likelihood of vision preservation and required an additional anesthetic episode to trim the conjunctiva. Partial dehiscence was also noted in the previously reported case using this technique.[11]

Conjunctival pedicle or 360° advancement grafting offers the advantage of providing the wound with an active blood supply. Tarsoconjunctival island grafting has been shown to be highly successful in stabilizing deep corneal ulcers, descemetoceles, and corneal perforations.[12] Rather than simply covering the defect, this technique has the advantage

of placing supportive tissue within the corneal defect. Free island grafting was not initially considered the technique of choice but the absence of a pedicle and the resultant low profile appears to have contributed to a reduced facility for self-trauma and traction on the graft. In this case, the island graft took considerably longer to vascularize than the 5 days described in dogs and cats.[19]

Operating microscopy was not available, nor was it possible to move the anesthetized patient into a sterile operating suite in this case. As a result of these 'field conditions,' it was necessary to use larger suture material than might have been selected under more optimal conditions. Significant additional difficulties were presented in this case by the challenges of restraint and medication as well as the inability to make use of protective collars, fly shields, or other means of ocular protection. As previously noted, although consideration was given to performing a temporary tarsorrhaphy following the graft procedure, it was felt that the intractable nature of the species combined with its extreme strength might have resulted in further self-trauma, and that tarsorrhaphy sutures probably could not have been removed without general anesthesia.

The horse represents the closest domestic animal model for the rhinoceros and decisions regarding medical treatment in this case were influenced by equine data.[13,14] *Staphylococcus* sp., *Streptococcus* sp., and *Pseudomonas* sp. are commonly isolated from equine eyes with ophthalmic disease.[9,12,15,16] *Staphylococcus* sp. has previously been isolated from an ulcerated cornea in a rhinoceros.[11] Fungal organisms may also be associated with corneal disease.[15–19] Based on the prevalence of fungal organisms isolated from equine ocular lesions in Florida, it was felt prudent to initiate antifungal treatment until corneal cytology could be evaluated. Additionally, unidentified yeast was previously cultured from an ulcerated lesion in the eye of a captive rhinoceros.[11] No fungal organisms were noted in the cytology from this case. The clinical relevance of the *Acremonium* isolate is not known and this case resolved without prolonged antifungal therapy. *Acremonium* sp. have been found to be the most common isolate from fungal corneal keratitis in humans in Paraguay.[20]

Tear film and corneal proteases including matrix metalloproteinases and serine proteases may be liberated into corneal wounds by degrading corneal epithelial cells, stromal fibrocytes, inflammatory cells, and some bacteria and overexpression of these enzymes or reduction of natural antiprotease activity may result in pathologic keratomalacia or 'melting.'[9]

Excess protease activity associated with aggressive corneal stromal lysis may be treated topically using disodium ethylenediaminetetraacetic acid (EDTA), doxycycline, the synthetic MMP-inhibitor 'Ilomostat,' or autogenous serum.[21–23] Serum contains α2-macroglobulin, which has activity against MMPs and serine proteinases, and α1-antitrypsin, which has activity against serine proteinases.[23]

Equine herpesvirus 2 (EHV-2) has been associated with keratoconjunctivitis in several reports in horses, and experimental infection with EHV-2 resulted in conjunctivitis with virus present in two horses.[24] Although no herpesvirus was identified in this case, viral infection should be considered in cases of ocular disease in nondomestic species.

In conclusion, our experience with this case confirms that free island tarsoconjunctival island grafting offers the potential to achieve the goals of globe salvage, comfort, cosmesis, and potential limited vision. This may be particularly relevant or indicated in cases of nondomesticated species in which postoperative care and contact are limited.

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