Long-term Medical and Surgical Management of Chronic Pododermatitis in a Greater One-horned Rhinoceros (*Rhinoceros unicornis*): A Progress Report

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Abstract

This report discusses the ongoing treatment of an advanced case of bilateral, chronic pododermatitis in a 23-year old male *Rhinoceros unicornis*. Chronic pododermatitis is a poorly understood but common medical condition, which affects up to 28% of adult male *R. unicornis* in captivity. It generally affects the hind feet and is characterized by non-healing fissures and ulcers located between the sole of the central toe and the adjacent pad and by pad overgrowth, bruising and chronic infection. Potential contributing factors include massive body size and weight, inappropriate housing conditions and husbandry techniques and genetic predisposition. The management plan for this animal includes improvements in husbandry techniques and medical and surgical therapy. Medical intervention based on bacterial and fungal culture of lesions has included oral anti-microbial medication and topical application of copper sulfate and oxytetracycline by means of a footbath. Surgical intervention involves regular debridement, aggressive trimming and paring of overgrown hoof tissue and the periodic application of collagen to stimulate granulation. In order to perform surgery on this animal, 25 chemical immobilizations have been performed during the past 58-months. Safe, repeated chemical restraint is achieved using combinations of etorphine, detomidine and ketamine injected intramuscularly. Intravenous ketamine supplementation following induction is utilized to improve immobilization and muscle relaxation and permit relatively invasive surgical procedures to be performed without significant or premature arousal. Regular assessment of hoof conformation and appearance is combined with thorough hoof trimming and nail care performed during anesthetic procedures. Changes in husbandry have included the addition of wood-mulch or cardboard substrate to the concrete flooring during winter holding, providing access to large areas of natural ground with free access to ponds and water and a diet that incorporates grass and natural browse. These changes in husbandry and the long-term therapeutic regimen have resulted in significant improvements in the appearance of lesions and in ambulatory comfort for the animal. The potential role of nutritional factors (zinc) is currently being investigated.

Introduction

The Greater one-horned rhinoceros, *Rhinoceros unicornis*, is endangered in the wild with only approximately 2,400 individuals remaining in the range states (IUCN/ARSG and International Stud book – August, 2000). Currently, there are 139 animals registered in the

international captive breeding program. Published records indicate that the rate of reproduction remains insufficient to sustain an independent captive population.

R. unicornis have been reported to be generally healthy and long-lived in captivity however a recent report by von Houwald and Flach describing the prevalence of chronic pododermatitis in captive animals suggests this might not be the case. Chronic foot disease (CFD) in *R. unicornis* was first reported in the literature by Strauss and Siedel in 1982 who recorded a condition in an adult male which was characterized by overgrowth of the middle toe, separation of the toe from the main weight-bearing pad and interdigital papillomatous growths, similar to those observed in proliferative digital dermatitis in cattle. Similar cases have been reported by Goltenboth, Mayer and Saksefski and Von Houwald and Flach.

CFD tends to involve one or both hind feet and is characterized by separation of the middle toe from the weight-bearing pad, non-healing fissures and ulcers between the sole and adjacent pad and by overgrowth of the middle toe and interdigital papillomatous or hyperplastic growths, often complicated by contusion and chronic infection. The condition appears to be more common in males than females and may affect up to 28% of males in captivity (von Houwald and Flach). Potential etiological factors include massive body size and weight, inappropriate housing conditions and husbandry techniques as well as possible genetic predisposition. Once the condition becomes chronic, treatment becomes difficult and is frequently unrewarding.

Case Report

An 18-year old, male, *R. unicornis* was presented to the Animal Health Department at *the Wilds* in 1996. Captive born and zoo-raised, this animal developed characteristic CFD lesions (initially affecting the right hind limb but eventually affecting all four feet), approximately 8 years prior to shipment. Despite periodic debridement of affected tissue, no significant improvement had been noted prior to transfer. Historically, this animal was maintained in a holding stall with concrete flooring for long periods.

On initial examination at *the Wilds*, severe, bilateral, hind-limb lameness was noted. Lesions were described as large, poorly healing fissures and ulcers located between the sole of the middle toe and the adjacent pad, purulent inflammation, pad overgrowth and bruising. Based on histopathological findings a morphologic diagnosis of severe, chronic-active, fibrosing and suppurative pododermatitis with intralesional bacteria (including *Dermatophilus*) was made. Subsequent to the first clinical evaluation at *the Wilds*, this animal has been managed as follows:

Treatment Plan

1. Medical therapy
2. Husbandry and Management changes
3. Surgical therapy

1. Medical therapy

- Oral and systemic anti-microbial treatment based on culture results.
- Oral and systemic anti-inflammatory therapy as indicated.
- Regular application of a moisturizing agent to alleviate skin dryness (associated with artificial heating and winter housing).

- Regular bathing of the affected feet in a medicated foot bath (copper sulfate and oxytetracycline powder).
- Periodic application of bovine-derived collagen particles following surgical debridement.

2. Husbandry and management changes

- Routine assessment of foot conformation, appearance, ease of ambulation and perceived comfort by animal management personnel.
- Application of a surface cover (consisting of wood mulch or recycled cardboard substrate) to the concrete flooring in the winter holding stall.
- Access to expansive natural grassland areas and natural vegetation during warm weather.
- Unlimited access to water and a mud wallow.
- Nutritional supplementation protocol for period of winter housing currently being evaluated.

3. Surgical therapy

- Regular (every 8 weeks) debridement, aggressive trimming and paring of overgrown hoof tissue and angle modification of weight-bearing surfaces of the affected feet to reduce adverse spreading and shearing forces associated with male behavior (e.g. foot-scraping), pacing/running and normal ambulation.
- Regular tissue biopsy to assess pathological changes.
- Periodic radiographic evaluation.
- Topical treatment of foot lesions (copper naphthenate) following surgical intervention.

Pathology

Histopathological examination of tissues (surgical biopsies from affected feet) collected in 1996 revealed severely hyperplastic stratified squamous epithelium. The epithelium surface was eroded and the overlying crust consisted of neutrophilic debris, hemorrhage, fibrin, serous exudate, bacterial cocci and rods and some bacteria with a railroad track appearance strongly suggestive of *Dermatophilus congolensis*. Deeper in the tissues, compact, dense, well-vascularized, fibrous connective tissue, consisting primarily of collagen, was present. Examination of a single discrete foot pad lesion clinically resembling papillomatous digital dermatitis in cattle, revealed hyperkeratosis with focal parakeratosis and papillae formation. No evidence of spirochete invasion was found. In 2001, serial sections from the same location revealed sheets of keratinocytes with multifocal areas of hydropic degeneration, irregular margins and entrapment of various bacterial rods and cocci. Parakeratotic hyperkeratosis has been recently noted in skin biopsies derived from the facial skin and ears.

Immobilization

In the interests of human and animal safety and in order to achieve the prolonged periods of recumbency and analgesia required to perform surgical therapy, chemical immobilization was chosen as the preferred method of restraint in this case. This rhinoceros has been

successfully immobilized 25 times over a 58-month period at approximately 8 - 10 week intervals. Other invasive clinical procedures including sample collection, skin biopsy and electroejaculation are also carried out during these restraint episodes.

Of the 25 chemical immobilizations, 17 were performed using a mean dose of 3.35 mg etorphine and 12.6 mg detomidine (M99-D) administered by projectile dart. Due to volume limitations, these combinations did not include ketamine, however, this drug was routinely administered intravenously to maintain anesthesia for all procedures. Eight immobilizations used a mean dose of 3.7 mg etorphine, 14 mg detomidine and included 400 mg ketamine (M99-K-D) in the initial combination and were administered by pole syringe. On each occasion, lateral recumbency and surgical anesthesia were achieved and the effects of etorphine were satisfactorily antagonized with naltrexone (range of 150mg - 300mg divided IV/IM). For procedures using M99-D alone, sternal recumbency was achieved in 16.59 minutes (±8.87), duration of recumbency was 65.8 minutes (±22.2) and standing and normal ambulation were achieved 3.5 minutes (±1.7) following antagonism. Mean heart rate was 60 bpm, mean respiratory rate was 11 bpm and mean SaO_2 was 87%. For procedures using M99-K-D, sternal recumbency was achieved in 7.6 minutes (±2.4), duration of recumbency was 76.6 min (±24.5) and standing and normal ambulation was achieved 2.4 min (±0.5) after reversal. Mean heart rate was 56 bpm, mean respiratory rate was 9 bpm and mean SaO_2 was 87%. During each restraint episode, the depth of anesthesia achieved was deemed adequate to perform minor surgical procedures, specimen collection and electroejaculation. Due to the prolonged duration of each procedure, a 100 - 250mg bolus of ketamine was administered IV every 20 to 30 min (or as required) to maintain the animal in a satisfactory plane of anesthesia.

Discussion

The following important factors should be considered:

1. This disease process (CFD) has a very high prevalence in captive *R. unicornis* with an estimate of 28% of males in European and North American zoological facilities being affected.
2. Improvement in gross appearance of chronic lesions and return to soundness requires a broad, multi-faceted clinical approach with significant, intensive and sometimes aggressive therapy.
3. Adequate restraint is necessary in the interests of safety and for the application of appropriate therapeutic options. Repeated chemical immobilization using combinations of opioids and other agents may be routinely and safely performed.

Strict adherence to the treatment protocol has resulted in a significantly improved clinical appearance of foot lesions in addition to improved levels of comfort and ease of ambulation for the animal. Long-term management has effected a return to 'relative' soundness but has not resulted in complete resolution of the foot lesions. Reassessment of prior biopsy results, and a recent histopathologic diagnosis of parakeratotic hyperkeratosis in skin biopsies taken from other areas of the integument, suggests that nutritional factors such as zinc may play a role in the etiology of this disease process. These factors are being investigated further and will be reported at a later date.

Selected references

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