JAVMA

AVMA

# A novel case of tracheal injury secondary to gunshot trauma in a white rhinoceros (*Ceratotherium simum*)

Mathew P. Gerard, BVSc, PhD, DACVS[1]*; Anthony T. Blikslager, DVM, PhD, DACVS[2]; H. Johan Marais, BVSc (Hons), MSc[3]

[1]Department of Molecular Biomedical Sciences, College of Veterinary Medicine, North Carolina State University, Raleigh, NC
[2]Department of Clinical Sciences, College of Veterinary Medicine, North Carolina State University, Raleigh, NC
[3]Saving the Survivors, Pretoria North, South Africa

*Corresponding author: Dr. Gerard (mgerard@ncsu.edu)

Received May 18, 2023
Accepted June 22, 2023

doi.org/10.2460/javma.23.05.0254

**OBJECTIVE**
To describe a case of tracheal injury secondary to gunshot trauma in a rhinoceros.

**ANIMALS**
5-year-old female white rhinoceros (*Ceratotherium simum*).

**CLINICAL PRESENTATION, PROGRESSION, AND PROCEDURES**
The rhinoceros was found alive with an apparent bullet entry wound cranial to the left shoulder. The rhinoceros was agitated and had bilateral epistaxis and increased respiratory noise. Immobilization of the animal facilitated closer examination and initiation of medical therapy. Radiographs obtained of the neck region at this first examination were nondiagnostic. Subsequent immobilization events allowed for further diagnostics and treatment.

**TREATMENT AND OUTCOME**
Initial treatment included a broad-spectrum antibiotic and a corticosteroid. Five days following the injury, the rhinoceros was considered stable, and the animal was immobilized to investigate the cause of the epistaxis and respiratory signs. Tracheoscopy revealed a full-thickness penetrating wound in the mid to caudal region of the trachea, and the surface of a metallic projectile was viewed within the wound. Medical treatment was continued and the rhinoceros was managed conservatively. At 14 days, radiographs of the neck made with a more powerful unit revealed tissue emphysema dorsal to the trachea. A subsequent tracheoscopy 54 days after injury revealed a granulated wound. Follow-up at 4 years after injury determined that the rhinoceros was reported to be behaving normally and had successfully calved.

**CLINICAL RELEVANCE**
Gunshot wounds associated with poaching are a prevalent problem in rhinoceros in Africa. Although more aggressive therapy including surgery may likely be considered in zoo or domestic animals, limited conservative treatment was successful in this wild-managed rhinoceros.

**Keywords:** rhinoceros, tracheal wound, gunshot, poaching, endoscopy

## History

A 5-year-old approximately 900-kg female white rhinoceros (*Ceratotherium simum*) was reportedly shot in an attempt to poach its horns. The animal was housed in a 250-m$^2$ enclosure in a provincial game reserve in South Africa. During the same overnight poaching incident, a second rhinoceros in the enclosure was killed by gunshot, and it was found with its horns removed. The morning following the poaching incident, the surviving rhinoceros was examined. Observing the animal from outside the enclosure, it appeared restless and agitated, and a penetrating hemorrhagic wound was noted cranial to its left shoulder joint **(Figure 1)**. Labored breathing, abnormal respiratory noise, and bilateral epistaxis were also present.

## Diagnostic Findings and Interpretation

To facilitate closer examination at the first emergency visit, the rhinoceros was immobilized with a 2-mL, 14-gauge projectile pneumatic dart using a combination of etorphine (0.003 mg/kg, IM) and azaperone (0.3 mg/kg, IM) in the right neck region, re-

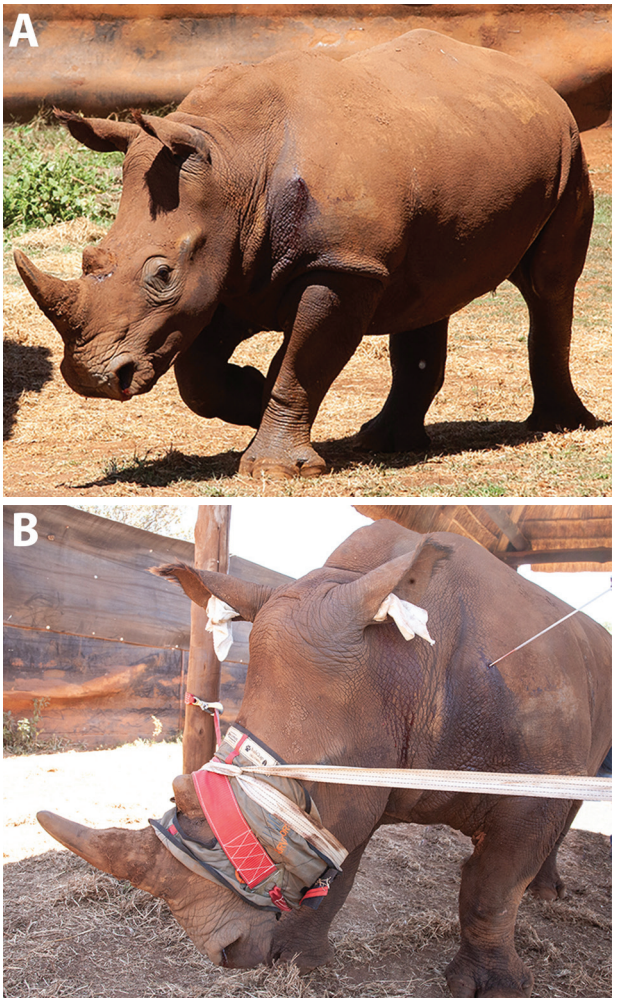


**Figure 1**—A 5-year-old approximately 900-kg female white rhinoceros (*Ceratotherium simum*) observed at the first examination with visible evidence of a penetrating wound at the level of the left cranial shoulder region, caused by a high-velocity projectile. Epistaxis is present at both nares, more apparent on the left in this image (A). Following chemical and physical restraint of the rhinoceros and reduction of external stimuli by blindfold and ear plugs, a sterile, 75-cm equine artificial insemination pipette was inserted into the wound. This procedure identified the steeply angled path of the projectile, in a slightly cranial and primarily ventromedial direction, toward the caudal neck and pectoral region (B).

sulting in profound standing sedation. The animal was blindfolded and earplugs were inserted to aid in reducing the animal's distress and reaction to external stimuli. A head rope was secured to assist with steadying the animal. The circular, 1-cm-diameter wound was immediately cranial to the point of the left shoulder joint and consistent with a bullet entry wound. Dried blood surrounded the wound and it was oozing a serosanguinous fluid. To explore the direction of the wound path, a sterile, 75-cm equine artificial insemination pipette was inserted 12 cm into the wound (Figure 1). The pipette angled steeply in a slightly cranial and primarily ventromedial direction, toward the caudal aspect of the neck and pectoral region. Based on the history of gunshots being heard the previous night, a diagnosis of high-velocity projectile injury was made. Radiographs of the neck were obtained but were not of diagnostic value because of the thickness of the tissue and limits of the x-ray generator. Although it was apparent from the clinical signs that the respiratory tract was compromised, the degree of trauma was unknown. Endoscopic examination of the respiratory tract was indicated and requires recumbent immobilization to perform. However, the risk of a longer recumbent immobilization with associated negative cardiorespiratory effects was considered too great in this unstable animal at this first visit. Therefore, further invasive diagnostic procedures were delayed, to allow for monitoring of clinical progress and response to initial medical therapy. The rhinoceros was administered ceftiofur single-dose formulation (6.6 mg/kg, IM) and dexamethasone (0.1 mg/kg, IM) and remained in its enclosure. The top differential diagnoses were gunshot traumatic injury to the upper respiratory tract and gunshot injury to the lower respiratory tract, and tracheoscopy was planned, if and when the rhinoceros was considered more clinically stable.

Five days after the original visit and trauma incident, the rhinoceros was reexamined by observation and assessed to be stable for a second immobilization. The animal was darted with the same combination as previously described, with the addition of ketamine (0.2 mg/kg, IM) to induce recumbency. On this occasion, respiratory tract endoscopy was performed with a 2.5-m (10.4-mm-diameter) videoendoscope. Thick, sanguinous mucus and fresh and clotted blood were identified in the nasal cavity and nasopharynx. Mucus and blood were viewed tracking from the larynx and the proximal trachea. The source of blood was traced caudally in the trachea to a major disruption of the left dorsolateral tracheal wall **(Figure 2)**,

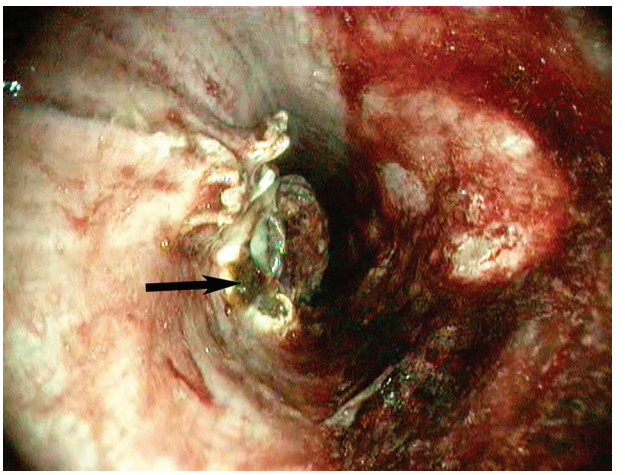

**Figure 2**—Day 5 endoscopic view of the tracheal trauma sustained by the rhinoceros described in Figure 1. Disruption of the left dorsolateral tracheal wall is evident, measured via the endoscope at 110 cm from the nostril. The wound has irregular margins with separated flaps of tracheal wall peeled back luminally, consistent with external wall impact by a high-velocity projectile. The surface of the projectile is visualized within the margins of the wound (black arrow). The surrounding tracheal mucosa is patchy red. Fresh blood and mucus have accumulated in the tracheal lumen.

measured via the endoscope at 110 cm from the nostril. The tracheal wound had irregular margins with separated flaps of tracheal wall peeled back luminally, consistent with external penetrating wall impact by a high-velocity projectile. The dull surface of the bullet was visualized within the margins of the wound. The surrounding tracheal mucosa appeared patchy red. The wound measured 5 cm in a cranial-to-caudal direction and 3 cm in a dorsal-to-ventral direction. Accumulation of fibrinous exudate was present within the wound. Endoscopy of the remaining 20 cm of the trachea wall caudal to the wound, to the level of the carina and beginning of the principal bronchi, was within normal limits.

## Treatment and Outcome

Following endoscopic confirmation of tracheal penetrating trauma in the caudal cervical region, the rhinoceros was administered a second dose of ceftiofur single formulation, IM, and flunixin meglumine (1.1 mg/kg, IM). The animal was observed daily to monitor the external wound, nasal discharge, respiratory effort, attitude, appetite, and fecal output. At a third clinical examination performed 14 days after injury, the rhinoceros exhibited normal behavior, and the cutaneous wound appeared dry and was contracting. There was no evidence of nasal discharge at the time of the examination. The rhinoceros had comfortable respiratory effort and rate. Lateral radiographs were obtained of the neck region using a higher-powered x-ray generator, and in the cranial half of the neck, fascial planes of free gas dorsal to the trachea were identified **(Figure 3)**. Air in the soft tissues was attributed to the tracheal wall trauma and, based on the animal's clinical progress, it was considered a benign finding and that no additional treatment was warranted. The presence of a metallic foreign body was not confirmed via the radiographs. This was due to the tracheal wall injury being situated more caudally toward the thoracic inlet, in a region too thick for the x-ray unit's capabilities.

A final endoscopic examination was performed at 54 days after injury, and at the time there were no reported concerns. The rhinoceros was immobilized using the same protocol as described for the previous endoscopy. Yellow orange strands and accumulations of tenacious, thick mucus were identified endoscopically in the nasopharynx and trachea. The tracheal wall trauma site had contracted to a 4 X 2-cm area with an irregular granulating wound surface **(Figure 4)**. The cutaneous entry wound had healed. Follow-up by telephone at 1 and 4 years confirmed the rhinoceros was acting normal, with no observable concerns reported. The animal had successfully calved and was clinically doing well.


**Figure 3**—Left-to-right lateral radiographic view of the cranial neck of the rhinoceros described in Figure 1. Free gas is present in fascial planes dorsal to the trachea. The thick mammillated skin of the neck is evident superimposed over the radiolucent lumen of the trachea. The caudal portion of the circular pharyngeal diverticulum is visible (asterisk). Cranial is toward the left.

**Figure 4**—Day 54 endoscopic view of the progressively healing tracheal wound described in Figure 2. Proliferative nodular granulation tissue and fibroplasia have sealed the wound defect.

## Comments

This case was considered remarkable in that the white rhinoceros is near endangered and thus particularly worthy of veterinary intervention to maintain the currently low number of animals. Further efforts at documenting the anatomy of the upper airway are

warranted, because distinct structures such as an apparent dorsal pharyngeal diverticulum were noted while the tracheoscopy was conducted.

The trajectory of the bullet wound was presumed to have resulted from the shooter aiming from an elevated position on the wall of the enclosure, causing an angled dorsolateral-to-ventromedial wound that entered at the left shoulder region and embedded in the left dorsolateral tracheal wall. The type and final location of the bullet are unknown. Radiography did not identify the bullet, presumably because of the lack of ability to penetrate the thickness of the caudal neck. The bullet was identified in the wound bed at the first endoscopic examination. Ultimately, it is possible that the bullet was walled off and remained embedded adjacent to the trachea, migrated to a different tissue location, or emerged into the tracheal lumen and was expelled or contained within the lower airways. Although bullets are considered relatively clean because they are metallic and enter the tissue with considerable heat, they are still contaminating foreign bodies.[1] However, there were no apparent long-term complications of the bullet wound in this case.

The healing of the gunshot wound in this rhinoceros was noteworthy, particularly compared with an evolutionarily related species such as the horse.[2] An equine scoring system for gunshot wounds would have indicated that surgery was necessary (wound score of 7 based on suspected high energy of the gun, perforating nature of the wound, a moderately clean wound, with no apparent fractures).[1] However, it has been suggested that gunshot wounds involving the trachea can be managed conservatively in the horse,[1] as was described for the present case. Surgical exploration of the wound tract and tissue debridement was considered in this rhinoceros during the first weeks of management. In general, and more so in a field situation, such a procedure would be a substantial and risky event. The anatomy of the region, the depth and location of the wound tract, the size of the animal, and the time limitations of field immobilization would all be definitive challenges to successfully performing surgery in this case. As the animal made positive clinical progress, the need to perform surgery diminished. The lack of complications of tracheal perforation, peritracheal emphysema, and the extensive wound tract is perhaps indicative of the resilience of the rhinoceros when wounded.[3] Treatment of a rhinoceros in a game reserve or bush setting impacted the ability to consider more invasive procedures such as surgery, as compared with an animal in a zoo setting. Poaching of rhinoceros horn is the most common reason for wounding and killing white rhinoceros. The increased incidence of poaching has been fueled by the demand for rhinoceros horn in Asia (particularly China and Vietnam), where it is used as a traditional medical therapy and for signifying social status.[4] As an example of impact on the rhinoceros population, there are 2,600 white rhinoceros remaining in the Kruger National Park, representing a population decline of 75% since 2011 (down from 10,621).[5]

## Acknowledgments

The authors thank Dina Ibrahim, DVM; Kelsie Dougherty, DVM; and Haley Dodson, DVM, for technical assistance.

## Disclosures

The authors having nothing to disclose. No AI-assisted technologies were used in the generation of this manuscript.

## Funding

The North Carolina State University College of Veterinary Medicine Global Health program is gratefully acknowledged for travel and research financial support of Drs. Gerard and Blikslager.

## References

1. Munsterman AS, Hanson RR. Trauma and wound management: gunshot wounds in horses. *Vet Clin North Am Equine Pract*. 2014;30(2):453–466. doi:10.1016/j.cveq.2014.04.007
2. Tougard C, Delefosse T, Hänni C, Montgelard C. Phylogenetic relationships of the five extant rhinoceros species (Rhinocerotidae, Perissodactyla) based on mitochondrial cytochrome b and 12S rRNA genes. *Mol Phylogenet Evol*. 2001;19(1):34–44. doi:10.1006/mpev.2000.0903
3. Marais HJ, Glyphis ZG, Cremers NA. Medical grade honey: hope for wounded white rhinos. *Vet Anim Sci*. 2021;13:100196. doi:10.1016/j.vas.2021.100196
4. Rhino dialogues introduction. Department of Forestry, Fisheries, and the Environment, Republic of South Africa. Accessed May 11, 2023. https://www.dffe.gov.za/projectsprogrammes/rhinodialogues/introduction
5. Updated poaching numbers for the Kruger National Park. 2020. Accessed May 11, 2023. https://rhinos.org/blog/updated-poaching-numbers-from-kruger-national-park