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SOLITARY OSTEOCHONDROMA OF THE DISTAL THIRD METACARPAL BONE IN A TWO-YEAR-OLD WHITE RHINOCEROS (*CERATOTHERIUM SIMUM*)

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Abstract: A privately owned, 2-yr-old, 600-kg, intact male white rhinoceros presented with a progressive lameness of the left front limb of 8-mo duration with a focal swelling situated over the dorsoproximal aspect of third metacarpophalangeal joint. Radiographs of the affected limb showed a 28 mm × 26 mm exostosis at the dorsodistal third metacarpal bone. Surgical removal of the exostosis was performed and histopathologic examination confirmed a solitary osteochondroma. A follow-up examination 1 yr after surgical removal revealed total abolishment of the left front limb lameness. This report documents the first diagnosis and treatment of solitary osteochondroma in a white rhinoceros.

Key words: Bone disease, *Ceratotherium simum*, osteochondroma, white rhinoceros

BRIEF COMMUNICATION

A healthy, privately owned, 2-yr-old, 600 kg, intact male white rhinoceros (*Ceratotherium simum*) presented with a moderate, progressive lameness of the left front limb of 8-mo duration. On clinical examination a firm swelling could be palpated over the dorsoproximal aspect of the third metacarpophalangeal joint of the affected limb.

Radiographs of the affected limb showed a 28 mm × 26–mm single, smooth, well-marginated, semicircular exostosis at the dorsodistal third metacarpal bone (Fig. 1). Radiographs of the contralateral limb were normal, suggesting a monostotic lesion, although the possibility of other affected regions of the body could not be excluded. Differential diagnoses considered include healed fracture, solitary osteochondroma (monostotic form), chondrosarcoma, osteomyelitis, disseminated idiopathic skeletal hypervitaminosis A, skeletal coccidioidomycosis, or bone cyst. A preliminary diagnosis of a solitary osteochondroma was made based on the radiographic appearance, despite its unusual location. Because of the long duration and progression of the clinical signs surgical removal of the exostosis was recommended.

The white rhinoceros was placed under general anesthesia at Onderstepoort Veterinary Academic Hospital (OVAH). Anesthesia was induced with an intravenous bolus of midazolam hydrochloride 0.04 mg/kg (25 mg) (Dormicum, Roche, Northlands 2196, South Africa; 1 mg/ml) and ketamine hydrochloride 0.66 mg/kg (ketamine, Fresenius Kabi, Halfway House/Korsten 6014,1685, South Africa; 100 mg/ml); a further 200-mg ketamine bolus was required for tracheal intubation. Anesthesia was adequately maintained with 1.5% isoflurane (100% isoflurane, Isoflurane, Safeline Pharmaceuticals, Palm Court 1715, South Africa) delivered in oxygen (5 L/min) via a circle anesthetic machine with carbon dioxide absorption, as well as an intravenous infusion of ketamine hydrochloride 0.02 mg/kg/min and medetomidine hydrochloride 0.02 μg/kg/min (Domitor, Pfizer Animal Health, Sandton 2146, South Africa; 1 mg/ml) diluted in 200 ml lactated ringers solution (Intramed Ringers-Lactate solution, Fresenius Kabi). During general anesthesia 3.3 mg/kg etorphine hydrochloride (M99, Novartis South Africa, Isando 1600, South Africa; 9.8 mg/ml) was administered followed by a constant rate infusion at 1 μg/kg/hr. A constant-rate infusion of etorphine hydrochloride allowed for an additional analgesic effect as well as a reduction in the dose of isoflurane required during maintenance of anesthesia. Blood volume was maintained with intravenous infusion of a balanced electrolyte solution (Sabax Plasma Vet, Adcock Ingram, Johannesburg 2000, South Africa) at 10 ml/kg/hr through a 20-G intravenous (IV) catheter that was placed in the left auricular vein. Intraoperative pain and antimicrobial management included a single intravenous administration of meloxicam 0.6 mg/kg (Metacam, Boehringer, Randburg 2125, South Africa; 20

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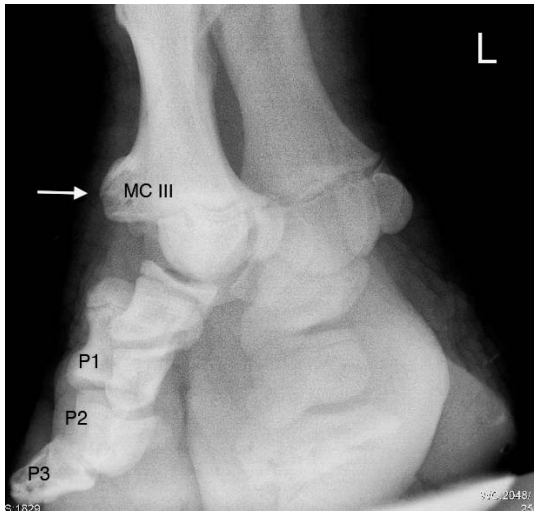

Figure 1. Lateromedial radiograph of the distal aspect of left front limb. There is a 28 mm × 26–mm monostotic, smooth, well marginated, semi-circular exostosis (arrow) at the dorsodistal third metacarpal bone. P1, phalanx one (proximal phalanx); P2, phalanx two (middle phalanx); P3, phalanx three (distal phalanx); and MC III, third metacarpal bone.

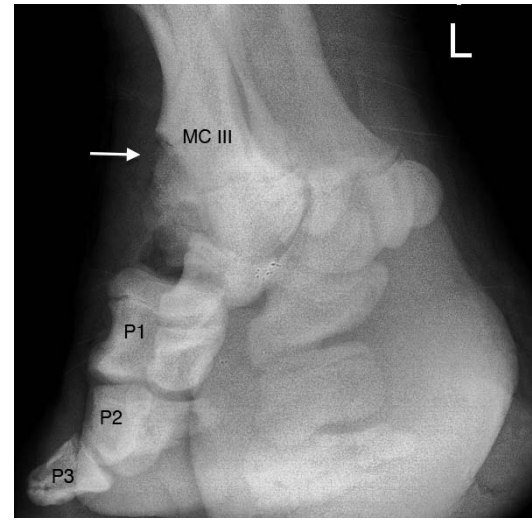

Figure 2. Intraoperative radiograph of the distal aspect of left front limb revealing complete surgical removal of exostosis (arrow) at dorsodistal aspect of third metacarpal bone. P1, phalanx one (proximal phalanx); P2, phalanx two (middle phalanx); P3, phalanx three (distal phalanx); and MC III, third metacarpal bone.

mg/ml) and sodium benzylpenicillin 22,000 IU/kg (sodium benzylpenicillin, Fresenius Kabi; 5 mIU), respectively.

The white rhinoceros was positioned in right lateral recumbency. A 15-cm skin incision was made over the firm swelling at dorsal aspect of the distal third metacarpal bone where the exostosis was identified with the use of intraoperative radiographs with skin metallic markers. Sharp and blunt dissection were performed through soft tissues until the exostosis could be identified. The exostosis was excised from the dorsodistal third metacarpal bone by the use of a 14-mm oscillating bone saw (Synthes oscillating saw, Bedfordview, 2007, South Africa) in combination with a mallet and chisel. Simple interrupted subcutaneous sutures of monofilament polydioxanone (PDS Suture, Ethicon, Halfway House 1685, South Africa; 4 metric) were placed, followed by placement of simple interrupted skin sutures of 1.5-mm orthopedic wire. Radiographs were taken intraoperatively to confirm the complete removal of the exostosis (Fig. 2). Postoperatively 2.4 mg diprenorphine hydrochloride (M5050, Novartis South Africa, Isando 1600, South Africa; 12 mg/ml) was administered. No complications occurred from general anesthesia during the recovery. The white rhinoceros was discharged the same day because no housing facilities were available at OVAH. Strict confinement to a small boma was recommended for a period of 4 wk.

The excised bony mass was fixed in 10% buffered formalin and submitted for histopathology. Demineralization of the tissue in 8% nitric acid was necessary before routine histological processing and staining with hematoxylin and eosin (H&E) following standard methods could commence.

Histological sections of the proliferative bony mass were taken perpendicular to the periosteal surface of the parent bone and up to 15 mm deep (Fig. 3). Within the sections a region of well-differentiated laminated hyaline cartilage could be identified, it was characterized by centrally located resting chondrocytes in a typical chondroitin matrix with progressive chondroblastic activity towards the periphery of the mass, resembling the hypertrophic and proliferative zones of a physeal growth plate. This cartilaginous tissue showed typical ossification with infiltration of fibrovascular tissue and the formation of ossifying trabeculae towards the interface with the periosteum. At the periosteal surface, the bony trabeculae were almost entirely ossified and interdigitated with a thick fibrous periosteum of parent bone. These findings were consistent with the diagnosis of a solitary osteochondroma (monostotic form).

A private veterinarian immobilized the white rhinoceros 3 wk postsurgery on the game farm for

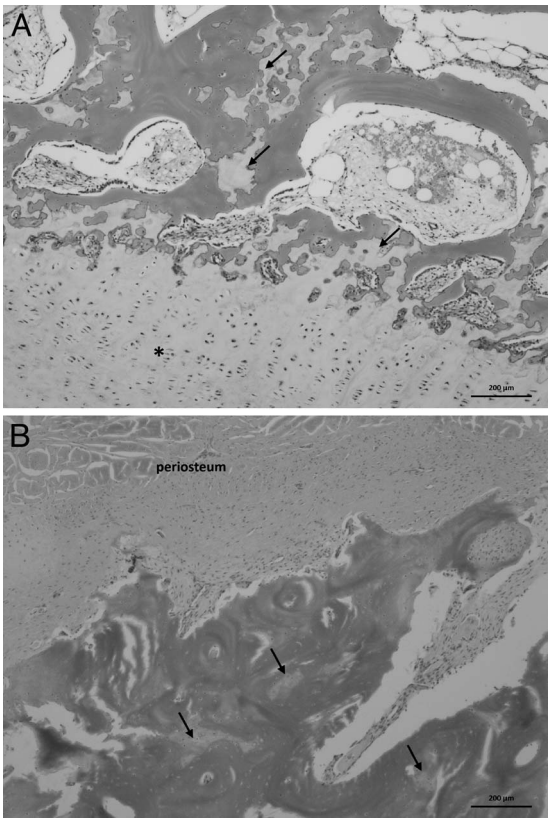

Figure 3. (A) Histological sections perpendicular to the periosteal surface up to 15 mm into the exostosis. Centrally situated laminar cartilaginous proliferation resembling the hypertrophic zone of growth plates (*) with trabecular ossification retaining unossified cartilage (arrows). Hematoxylin and eosin (H&E) stain, bar = 200 µm. (B) Peripheral subperiosteal region showing interrupted bony trabeculae at the periosteal interface and the presence of scant amounts of unossified cartilage (arrows). H&E stain, bar = 200 µm.

a visual follow-up examination and the removal of the orthopedic wire skin sutures. The surgical incision was healing satisfactorily and an improvement of the lameness was seen. A year after surgery, the animal was entirely sound, and radiographs taken on the game farm indicated no evidence of regrowth of the exostosis.

Osteochondromatosis is a benign proliferative disorder of bone and cartilage that arises from the surfaces of bones formed by endochondral ossification adjacent to the physis or subarticular growth plate.[15] This condition may be found either as a solitary (monostotic) lesion, which is referred to as an osteochondroma (OCM), whereas multiple cartilaginous exostoses (MCE) is the term used when multifocal (polystotic) lesions exist.[5] Osteochondromatosis has been reported in multiple species including humans, dogs, cats, horses, pigs, deer, rhesus macaques, and ring-tailed lemurs.[2,3,7,8,10,13,14] To the best of our knowledge, this condition has not been reported before in a white rhinoceros.[4]

The polystotic form of osteochondromatosis is inherited as an autosomal dominant trait in humans, dogs, and horses, whereas no hereditary link has yet been identified for the monostotic form.[10] Although these two forms are histologically and radiologically identical, they tend to differ etiologically and pathophysiologically.[5,10]

The exostosis is thought to result from a separation of a portion of the metaphyseal growth plate margin, creating an island of chondrogenic tissue that is capable of endochondral ossification. This island of tissue is then carried into the metaphysis as bone growth occurs, projecting from the metaphyseal surface, the marrow remains continuous with the marrow space of parent bone. The exostosis is covered by a cartilage cap. Several authors contemplate that the growth of the exostosis is stopped at skeletal maturity, whereas other authors are of the opinion that because clinical signs frequently develop after this time, slow periosteal growth may in fact occur after cessation of endochondral ossification.[6,11]

Bones that can be affected include vertebrae, ribs, long bones, digits, and the pelvis.[3] Outgrowths are most frequently found on the cortical surfaces of the metaphysis of bone, or towards the distal end of the diaphysis of long bones, but never on the epiphysis. This condition usually affects skeletally immature animals.[15] However, it is unknown when skeletal maturity is reached in a white rhinoceros.

Clinical signs depend on the size and the location of the exostosis and may only be noticed if the exostosis is situated where it interferes with normal anatomical function.[9] Signs can include a decrease in range of motion, pain, and lameness because of bony compression of tendons, ligaments, blood vessels, or spinal cord. In this rhinoceros, lameness was most likely due to impingement of adjacent extensor tendon and soft tissue structures by the monostotic exostosis.

Radiologically exostoses located at long bones or vertebrae have a smooth, even contour, and a thin cortex with no evidence of bony lysis or periosteal reaction evident, leading to a radiologically benign appearance.[1,5] The monostotic lesion seen in the white rhinoceros displayed similar radiographic benign characteristics as mentioned

above. In contrast, exostoses located at the ribs are irregularly marginated, with a heterogeneous radiographic appearance.

Histopathology is required for a definitive diagnosis. Histologically an exostosis is composed of trabecular bone contiguous with cancellous bone of the adjacent medullary cavity, covered by a characteristic cartilage cap composed of hyaline cartilage undergoing endochondral ossification.[15] The cortex at the base of the exostosis is continuous with the cortex of the parent bone.[12]

Differential diagnosis can include healed fracture, chondrosarcoma, osteomyelitis, disseminated idiopathic skeletal hypervitaminosis A, skeletal coccidioidomycosis, and bone cyst.[13] The diagnosis is largely based upon the age of onset, radiographic appearance, location, and histological findings. This case report describes the first documented monostotic lesion (solitary osteochondroma) in a young, white rhinoceros. The lesion was situated at an unusual location but fulfilled the clinical, radiographic, and histological description of a solitary osteochondroma, and was successfully treated through surgical removal.

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