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Case Report

Computed Tomography and Magnetic Resonance Imaging of a Rhinosinusitis Secondary to a Dental Abscess in a Crested Porcupine (*Hystrix cristata*)

Key words

porcupine,
dental abscess,
computed tomography,
magnetic resonance imaging

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Abstract: A captive crested porcupine (*Hystrix cristata*) adult male was imaged due to reduced food intake, anorexia, fever, nasal discharge, changes in fecal quantity and size, and respiratory difficulties. Advanced imaging diagnostic techniques such as computed tomography and magnetic resonance imaging were performed to evaluate the animal. These techniques were very helpful to delineate the dental abscess, as well as the extension of the process to other locations such as the nasal cavity and the tympanic bulla. This is the first description of rhinosinusitis secondary to a dental abscess in a crested porcupine.

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Introduction

In recent years, the introduction of modern diagnostic imaging techniques has improved the visualization of diseases in exotic mammal medicine. Traditionally, standard radiography has been used by clinicians (1). Nonetheless, results of previous works have proposed that computed tomography (CT) and magnetic resonance imaging (MRI) may provide more information to improve diagnostic accuracy, prognosis, and treatment of diseases (2, 3, 4). These techniques avoid the superimposition of adjacent anatomical structures and depict the anatomic detail of specific tissue densities more finely, which improves its interpretation (2). Moreover, the refinements in CT technology involve the application of computer software for the generation of three-dimensional (3D) reconstruction of an area of anatomic interest (5). These advantages have demonstrated great value for the diagnosis of several diseases in exotic mammal species (2 ,3, 4, 5). Some of these species, such as the crested porcupine (*Hystrix cristata*), appear in worrisome categories of the IUCN red list since are regionally or locally threatened and thus require appropriate conservation policies in regional and local contexts. It is a species of rodent in the family Hystricidae native to Italy and Sicily, and a broad central strip ranging from Senegal and west to Somalia and east to Kenya and Tanzania (6, 7).

Porcupine presents strong and pointed quills that cover their tail, sides and top of the body. Concerning its head, it is large and robust with an enlarged infraorbital foramen so that portions of the masseter extend through it and arise from the frontal side surface of the snout (8). The anatomy and physiology of their oral cavity can produce several dental disorders. The teeth of rodents grow continuously (incisors in all species and molars in some species), therefore, any disease affecting the positioning of teeth within this cavity and disrupting normal attritional movements will lead to overgrowth and malocclusion (2, 3). Nonetheless, their oral cavity is very difficult to examine because of its anatomic configuration; these features typically allow the evaluation of superficial changes (9). For these motives, new imaging modalities are of tremendous importance for

the assessment of teeth and surrounding structures (10). Therefore, the use of CT and MRI allows an accurate diagnosis of dental disorders since it is highly effective in visualizing soft tissues and, unlike conventional radiology, can be used to diagnose even small dental abscesses, as well as osteoarthritis of the temporomandibular joint and odontogenic tumours (2, 11).

Case Presentation

An adult male crested porcupine (*Hystrix cristata*) weighing 7,8 kg from Rancho Texas Lanzarote Park (Lanzarote, Canary Islands, Spain) was admitted to the Veterinary Hospital of Las Palmas de Gran Canaria University (Canary Islands, Spain) to be imaged due to medical history of weight loss, reduced activity and food intake, anorexia, fever, mucopurulent nasal discharge, reduced stool production, and respiratory difficulties. The blood collection revealed mild anemia, marked lymphopenia, hypoglycaemia, hypoalbuminaemia, slightly high serum urea concentrations, and low potassium levels.

To perform the imaging study and evaluate the animal, we sedated the porcupine using a combination of dexmedetomidine (0,25 mg/kg IM, DEXDOMITOR®, Ecuphar, Barcelona, Spain) and ketamine (25 mg/kg, Imalgene®, Boehringer Ingelheim, Barcelona, Spain). No physical abnormalities were observed when we checked the head, However, the inspection of its oral cavity revealed an abscess of the right maxillary molar tooth and halitosis. The images were obtained using a 16-slice helical CT scanner (Toshiba Astelion, Toshiba Medical System, Madrid, Spain). The animal was positioned symmetrically in sternal recumbency on the CT couch, and a standard clinical protocol (120 kVp, 80 mA, 512 X 512 acquisition matrix, 1809 x 858 field of view, a spiral pitch factor of 0,94, and a gantry rotation of 1,5 s) was used to acquire sequential transverse CT images of 1 mm thickness slice. To optimize the CT appearance of the head structures, two CT algorithms (bone/

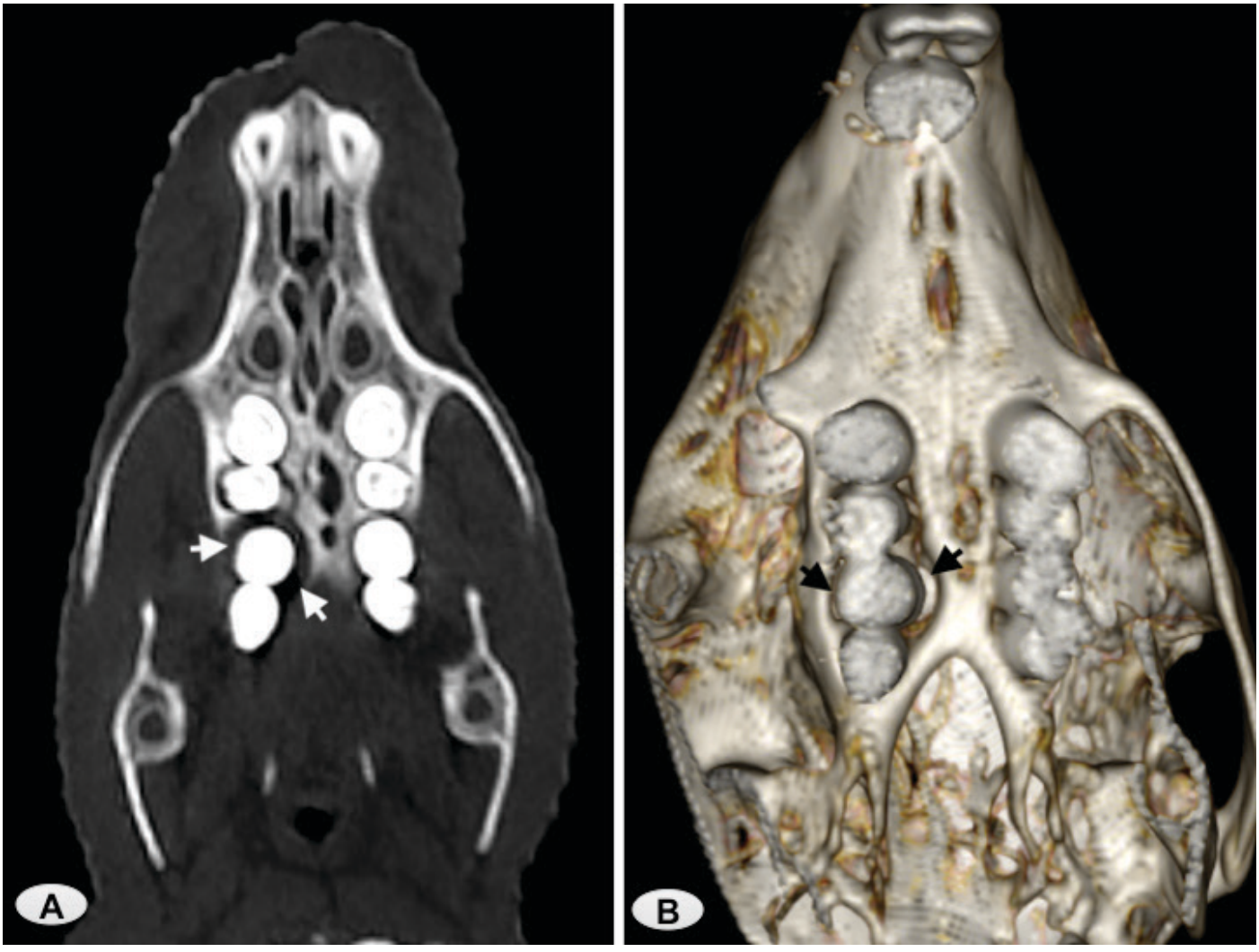

Figure 1: A) Dorsal MPR image of the porcupine head, bone window. The image displays an increase of the alveolar space corresponding to the third right maxillary molar tooth (white arrows). B) Volume-rendered reconstruction image of the porcupine head, displaying the dentary abscess (black arrows)

pulmonary algorithm), and two windows were applied by adjusting the window widths (WW) and window levels (WL): a bone window setting (WW=1500; WL=300) and a soft-tissue window setting (WW=350; WL=40). Multiplanar reconstruction (MPR) of CT images was performed to improve the visualization of the normal anatomy of the affected area as well as greater diagnostic accuracy of the extension of the disease. In addition, the original data were used to generate volume-rendered reconstructed images after manual editing of the transverse CT images to remove soft tissues using a standard Dicom 3D format (OsiriX MD, Geneva, Switzerland).

The CT and volume rendering reconstruction images displayed an increase in the alveolar space corresponding to the third right maxillary molar tooth (Figure 1). This alveolar space was hypoattenuating concerning the subjacent soft tissue. The rest of the oral cavity appeared unremarkable without any sign of disease. The nasal cavity and paranasal sinuses showed a large amount of fluid collection affecting both sides (more marked on the right side) that were hyperattenuated in the transverse and MPR images (Figure 2, 4a). No other remarkable findings were observed.

The MRI study was conducted with a 1.5-Tesla magnet (Toshiba, Vantage Elan, Japan) with the animal placed in ventral recumbence. A standard MRI protocol was used to generate spin-echo (SE) T1-weighted, and T2-weighted images in sagittal, transverse, and dorsal planes. SE T1-weighted transverse images were acquired with the following settings: Echo time (TE), 10 ms, repetition time (TR), 800 ms, acquisition matrix of 536 x 384, and 4,5 mm slice thickness with 4 mm spacing between slices. For SE T2-weighted transverse images, the TE 120 ms, TR 10541 ms, acquisition matrix 624 x 448, and 3 mm slice thickness with 3 mm interslice spacing. For SE T2-weighted sagittal images, the TE 120 ms, TR 7529 ms, acquisition matrix 512 x 804, and 2,8 mm slice thickness with 2 mm interslice spacing. For SE T2-weighted dorsal images, the TE 120 ms, TR 8282 ms, acquisition matrix 468 x 512, and 3,4 mm slice thickness with 3 mm interslice spacing. We used a medical imaging viewer (OsiriX MD, Geneva, Switzerland) to evaluate the images of the study.

Dorsal, transverse, and sagittal MR images of the porcupine head are presented (Figures 3, 4B). These images showed an increase of the alveolar space corresponding

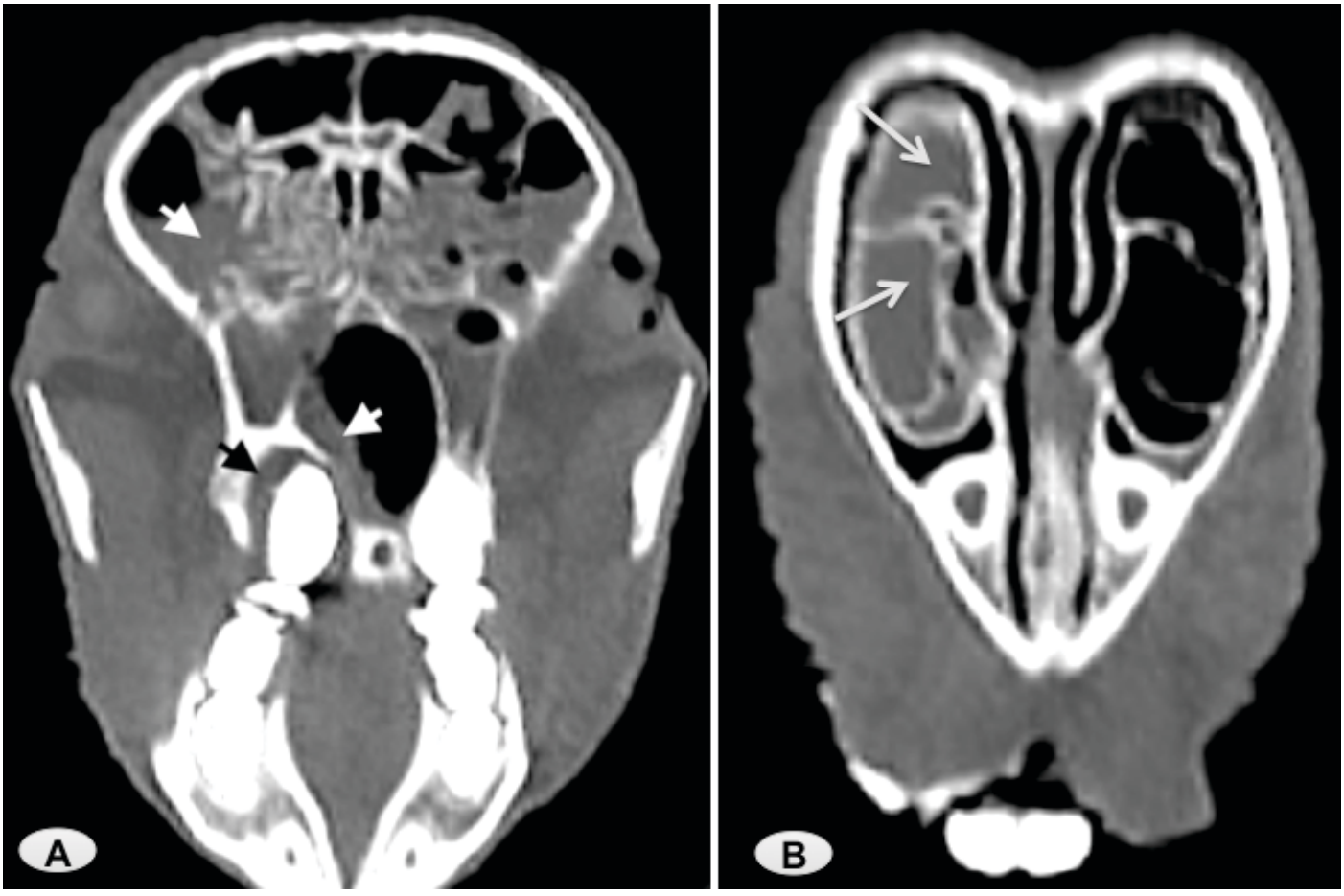

Figure 2: A) Transverse CT image of the porcupine head, bone window. The image shows an increase of the alveolar space corresponding to the third right maxillary molar tooth (black arrow). This increased space produced deviation to the right midline of the right wall of the nasopharynx (white arrow). In addition, there was a fluid collection in the paranasal sinuses (white arrow). B) Transverse CT image of the porcupine head, bone window. The image shows fluid collection in the dorsal and ventral nasal conchae (white arrows)

to the third right maxillary molar tooth. The increase of the alveolar space was hyperattenuated in T2W images when compared with the subjacent soft tissue. The dorsal and sagittal T2W images depicted abundant fluid collection in the nasal cavity and paranasal sinuses (Figures ·3A, 4B). In addition, the tympanic bullas showed a slight amount of fluid that was hyperintense in the T2W transverse images (Figure 3B). No other Imaging findings were identified.

We submitted samples of the fluid collection for aerobic and anaerobic bacterial culture. These were performed using sterile cotton swabs in a transport medium (Eurotubo®, Rubi, Barcelona, Spain). The swab was introduced 2-4 cm into the medial aspect of each nare and was stored and kept at 4 ºC until further processing in the laboratory. Later, samples were inoculated on Blood agar, MacConkey agar, Baird parker agar, and sabouraud agar. Plates were incubated at 37 ºC for 24 hours. There was bacterial growth on blood agar and Baird parker agar. We also performed a Gram stain, resulting in gram-positive cocci in pure culture. Subsequently, the API 20 Staph gallery confirmed the presence of *Staphylococcus aureus*. The antimicrobial resistance was tested to select effective drugs for treatment with those antimicrobials used in people against staphylococcal infection (12). The antimicrobial sensitivity discs (Oxoid, England) were cephalexin, enrofloxacin, ciprofloxacin, and amoxicillin-clavulanic acid. With this result, we recommend enrofloxacin (15 mg/kg s.c. q24h) for 14 days. Unfortunately, medical treatment was ineffective so surgical therapy was performed to extract the affected tooth and instilment the surgical site with antibiotic preparations (doxycycline-containing polymer gel). Later, the porcupine was maintained with amoxicillin–clavulanate 7,5 mg/kg q48h s.c. for six weeks. Further evaluation of the animal revealed no further complications.

Discussion

To the authors' knowledge, the present study is the first to characterize CT and MRI findings of a dental abscess in a crested porcupine. Different reports have postulated that rodents can develop dental diseases in their lifetime and be

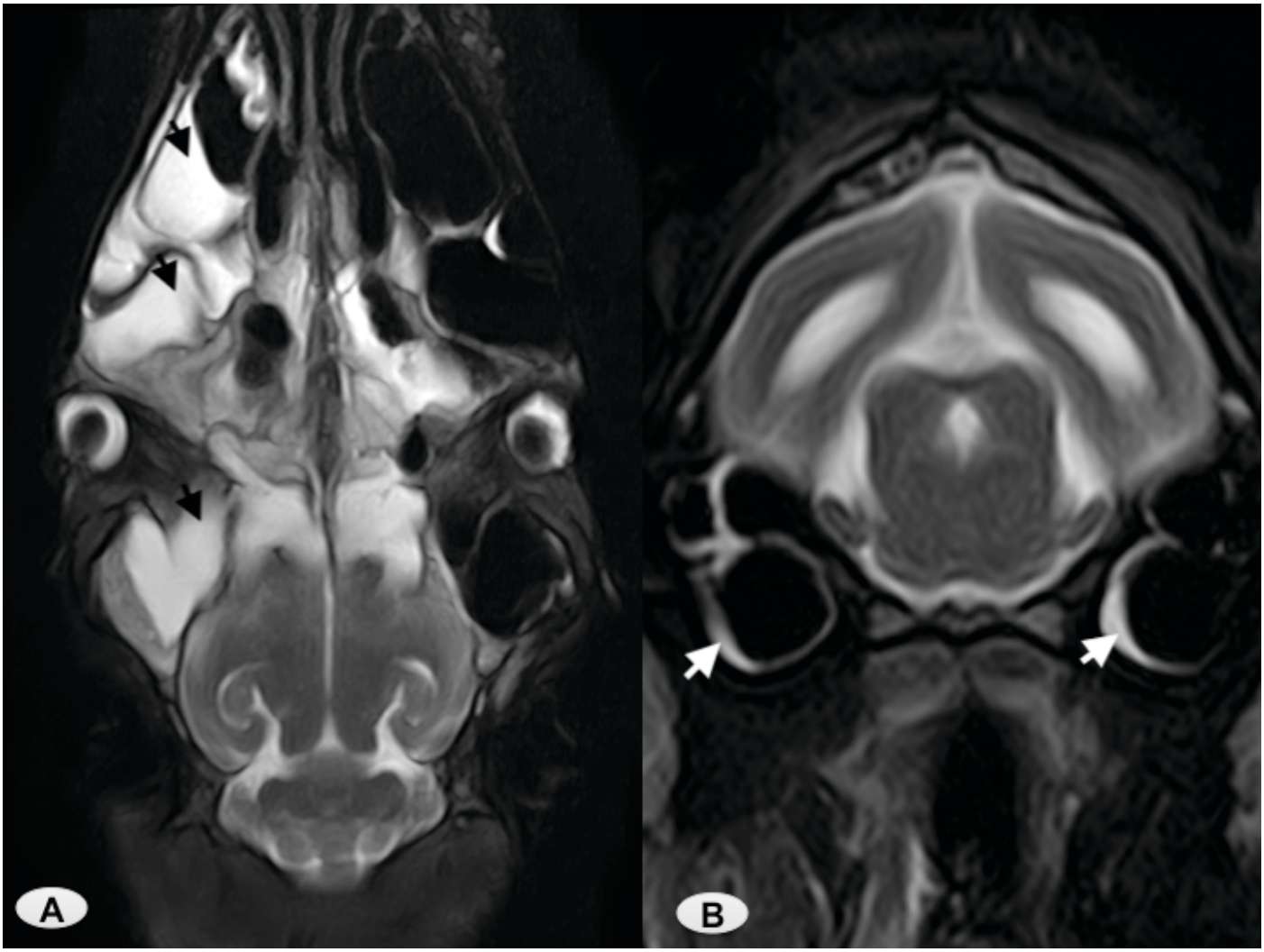

Figure 3: MRI of the porcupine head. A) T2W, dorsal image, displaying the fluid collection in the nasal cavity and paranasal sinuses (black arrows). B) T2W, transverse image. The image shows the tympanic bullas with a slight amount of fluid that is hyperintense (white arrows)

a cause of morbidity (13, 14) since these diseases may lead to infection of teeth and surrounding structures. Among these diseases, we highlighted dental abscesses, which are common in lagomorphs and rodents (10, 11, 15, 16). However, the singular aspects of its dental anatomy, physiologic characteristics, and host response make abscess diagnosis and treatment quite difficult (17). The aetiology of dental abscesses implies food and microorganisms being able to track up a loosened or broken tooth into the periodontal tissues and alveolar socket, resulting in the generation of an abscess associated with the maxilla or mandible, which can extend to the nasal cavity (17, 18). In this study, CT and MR images supported the diagnosis of rhinosinusitis secondary to dental associated infection. Information concerning rhinosinusitis in captive and free-ranging wildlife species is sparse. Thus, only a few reports have described this finding in rodents such as ground squirrels (19) or an orange-spined hairy dwarf porcupine (20), and as in our case, the nasal cavity inflammation was associated to *Staphylococcus* spp infection.

Diseases of incisors and cheek teeth result in clinical signs that could require appropriate imaging techniques to obtain a definitive diagnosis, formulate a prognosis, and develop a treatment plan. The use of radiographic imaging can be contemplated as a primary diagnostic tool to evaluate these processes. Unfortunately, the small size of rodents and the overlapping of the dental quadrants make radiographic evaluation quite arduous (18). Advanced diagnostic imaging such as CT and MRI have become popular in exotic mammal medicine since these techniques improve anatomic identification and lesion detection that allows accurate assessment, detailed prognosis, the diagnosis of underlying lesions and treatment choice (10, 18). CT has been widely used in rabbits to evaluate acquired dental disease and its associated problems, such as deformities and osteomyelitis, as well as the extension of the infection process to different bone cavities of the skull as the nasal or the paranasal cavities and the tympanic bullae (10, 11, 12). Therefore, the clinical signs are commonly related to the primary dental problem or complications connected with dental disease. The clinical signs observed in our animal such as anorexia, reduced food intake, excessive salivation, or nasal discharge were similar to those described in previous reports (10, 11, 12). Additionally, mild anemia, marked lymphopenia, and hypoglycaemia have also been reported in other animals with dental diseases (3, 14, 15).

In this study, a third-generation CT scan provided transverse and three-dimensional reconstructed images that gave an adequate overview of head morphology, displaying a good depiction of the affected areas. Thus, the transverse CT images were helpful to delineate the dental abscess, as well as the extension of the process to other locations, such as the nasal cavity and the tympanic bulla. Interestingly, other studies performed on rabbits showed similar Imaging findings (2, 3, 15, 16). Three-dimensional CT reconstruction is a helpful procedure to evaluate the extension of bony lesions with excellent detail by cropping part of the volume to evaluate deeper anatomic structures (5, 21). Hard and soft tissues can be added virtually or subtracted to different extents and degrees of density, providing a comprehensive relationship between soft and hard tissues. Shaded surface displays present a contoured surface map of the entire image volume, converting CT data into an image very similar to the depiction of an anatomic specimen (10). Despite these arguments, this technique has been infrequently used in exotic veterinary medicine. Three-dimensional CT reconstruction may be of critical importance for diagnostic accuracy and selecting the best

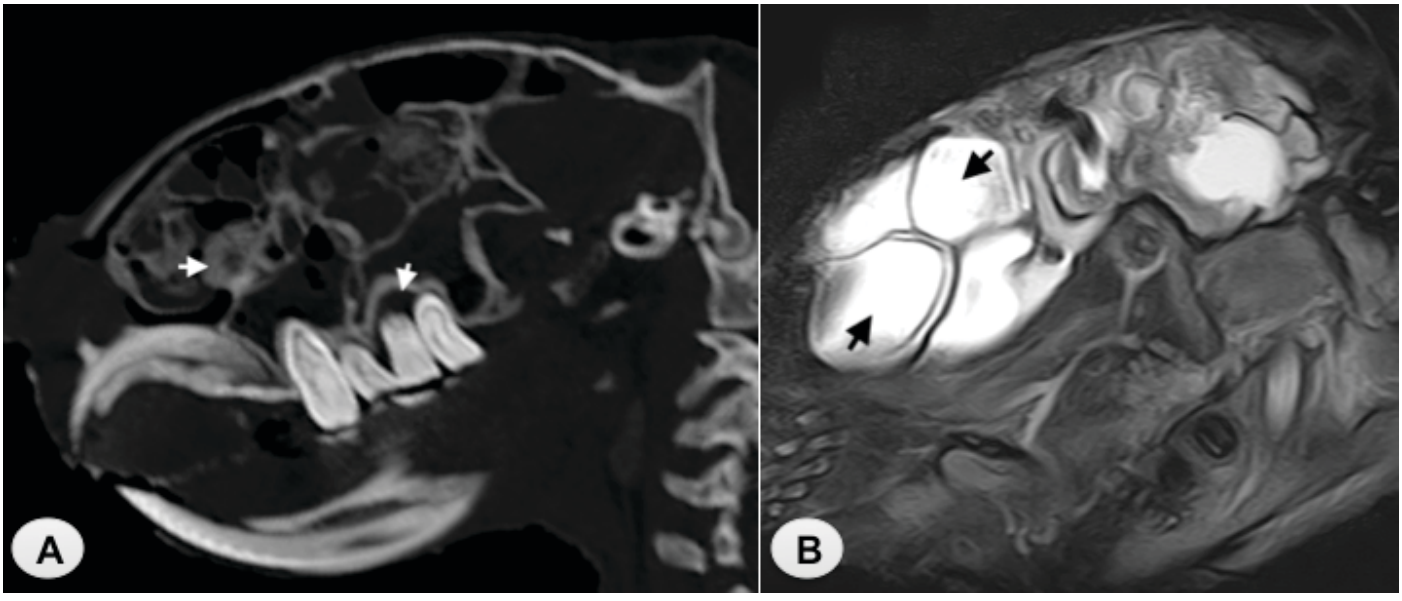

Figure 4: A) Sagittal MPR image of the porcupine head displaying the tooth abscess and the fluid collection in the paranasal sinuses (white arrows). B) T2W, sagittal image, displaying the abundant fluid collection in the nasal cavity and paranasal sinuses (black arrows)

surgical approach, depending on the nature and extension of the process. Thus, the use of this technique in rabbits has been quite helpful evaluating osteomyelitis, or dental and skull abnormalities (10). In our study, the images obtained by three-dimensional CT reconstruction displayed excellent detail of the dental abscess and the extension of the process to the nasal cavity, providing additional information to the transverse CT images.

In recent years, the contribution of MRI to the knowledge of exotic animals has increased (10, 11, 16). This Imaging technique displays soft tissues with excellent resolution. Therefore, an MRI of the head for reasons other than studies of the brain is a very helpful tool in pet rabbits and rodents to diagnose the presence and the extent of abscesses (10, 11, 16). In our study, we used a magnet of 1.5 T that provided T2W images with high resolution. These images displayed abundant fluid collection affecting the nasal cavity and the tympanic bulla, thus, diagnosing the presence and extension of the abscess.

Anaerobic and aerobic bacteria have been cultured from dental abscesses when pertinent techniques are used (17). Specific bacteria such as *Staphylococcus Aureus,* previously described to be important etiologic in rabbit dental infections (22), was isolated in our study. It is a versatile opportunistic pathogen that causes a wide spectrum of pathologies. It is also a mammalian commensal and opportunistic pathogen that colonizes niches such as skin, nares, and diverse mucosal membranes. The prevalence in animals varies from host species but colonization and infection have only been superficially investigated in small rodent wild animals (23) such as beavers, ground squirrels, red squirrels, or wood mice (24).

To summarize, advanced imaging diagnostic techniques such as computed tomography and magnetic resonance imaging were helpfully delineating the dental abscess and the extension of this process to other locations such as the nasal cavity and the tympanic bulla. It is the first time this pathology is described in crested porcupines by modern diagnostic techniques.

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Uporaba računalniške tomografije in magnetne resonance za slikanje rinosinuzitisa, nastalega zaradi zobnega abscesa pri afriškem ježevcu (*Hystrix cristata*)

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Izvleček: Odraslega samca afriškega ježevca (*Hystrix cristata*) v ujetništvu smo slikali zaradi zmanjšanega vnosa hrane, anoreksije, nosnega izcedka, sprememb v količini in velikosti iztrebkov ter težav z dihanjem. Uporabili smo napredne tehnike slikovne diagnostike, kot sta računalniška tomografija in magnetna resonanca. Te tehnike so bile zelo koristne pri opredelitvi zobnega abscesa in razširitve procesa na druga mesta, kot sta nosna votlina in timpanični del temporalne kosti. To je prvi opis rinosinuzitisa, ki je posledica zobnega abscesa pri afriškem ježevcu.

Ključne besede: ježevec; zobni absces; računalniška tomografija; magnetna resonanca