

ORIGINAL INVESTIGATION

Osseous lesions in the distal extremities of dogs with strangulating hair mats

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Abstract

Strangulating hair mats in dogs are characterized as soft tissue injury secondary to chronically matted hair, which can encircle the extremities and constrict lymphatic tissue and local vasculature. As the tissue swells, the hair constriction tightens and may result in tissue necrosis and osseous changes secondary to ischemic necrosis. The objectives of this retrospective case series were to describe the radiographic characteristics of persistent hair mat strangulation in dogs, to identify clinical features that would distinguish between dogs with soft tissue lesions only and dogs with osseous changes and to describe the clinical outcome in these dogs. All dogs with clinically identified strangulating hair matting had radiographically identified soft tissues defects and over half of the limbs evaluated had osseous lesions including focal periostitis, bone remodeling, bone atrophy, lysis of bone, and occasionally subluxation of joints. Chronically matted hair and strangulating hair mats in dogs are recognized by veterinarians as a medical finding in animal neglect. The osseous features of strangulating hair mats have not been described in the veterinary medical literature. This study describes the clinical features and radiographic characteristics of strangulating hair mats.

KEYWORDS

constrictive, ischemic necrosis, veterinary forensic

1 | INTRODUCTION

Neglect is a category of animal maltreatment and is an act of omission. While the legal definition of neglect will vary according to jurisdiction, neglect is generally characterized by a failure of the owner to provide basic needs of the animal, such as food, water, shelter, and veterinary care. In cases involving inadequate grooming, the hair coat of the animal may be unkempt, tangled, and/or matted. Chronically matted hair can encircle the distal extremities and strangulate the underlying tissue, causing ischemic necrosis and underlying bone loss.

Osteolysis secondary to ischemic necrosis associated with foreign objects has been reported in the dog and cat.^{1,2} In these prior reports, the foreign object was an elastic band that encircled the neck or a single forelimb. Radiography or CT identified the osteolysis and the elastic band. Soft tissue constrictive lesions associated with wet hair are described as a potential husbandry concern in the udders of cows.³ Long hair on the cow teat, made wet by a nursing calf, can encircle and

constrict the teat resulting in infection and necrosis of the quarter. A syndrome described in infants and children and variably described as hair-thread tourniquet, toe tourniquet, and hair-tourniquet syndrome is an uncommon occurrence of appendage strangulation by a constrictive strand of hair.⁴⁻⁶ This constrictive hair lesion has been reported in the fingers and toes of infants, resulting in lymphatic obstruction, edema, swelling, and in unrecognized cases, venous congestion, vascular occlusion, necrosis, and osseous erosion.⁷⁻¹¹ The skin can re-epithelialize over the embedded hair confounding the identification of the cause of the constriction.^{12,13} Although some of the imaging findings and histopathology results of the hair-tourniquet syndrome in children appear similar to strangulating hair matting in dogs, the cause of the hair constriction is clearly different. In dogs, the chronically matted hair is a form of neglect by the animal caregiver; however, in children the fine hair tourniquet is usually invisible to the caregiver and requires magnification to identify the cause of the constriction. Treatment of children with hair-thread tourniquet syndrome includes

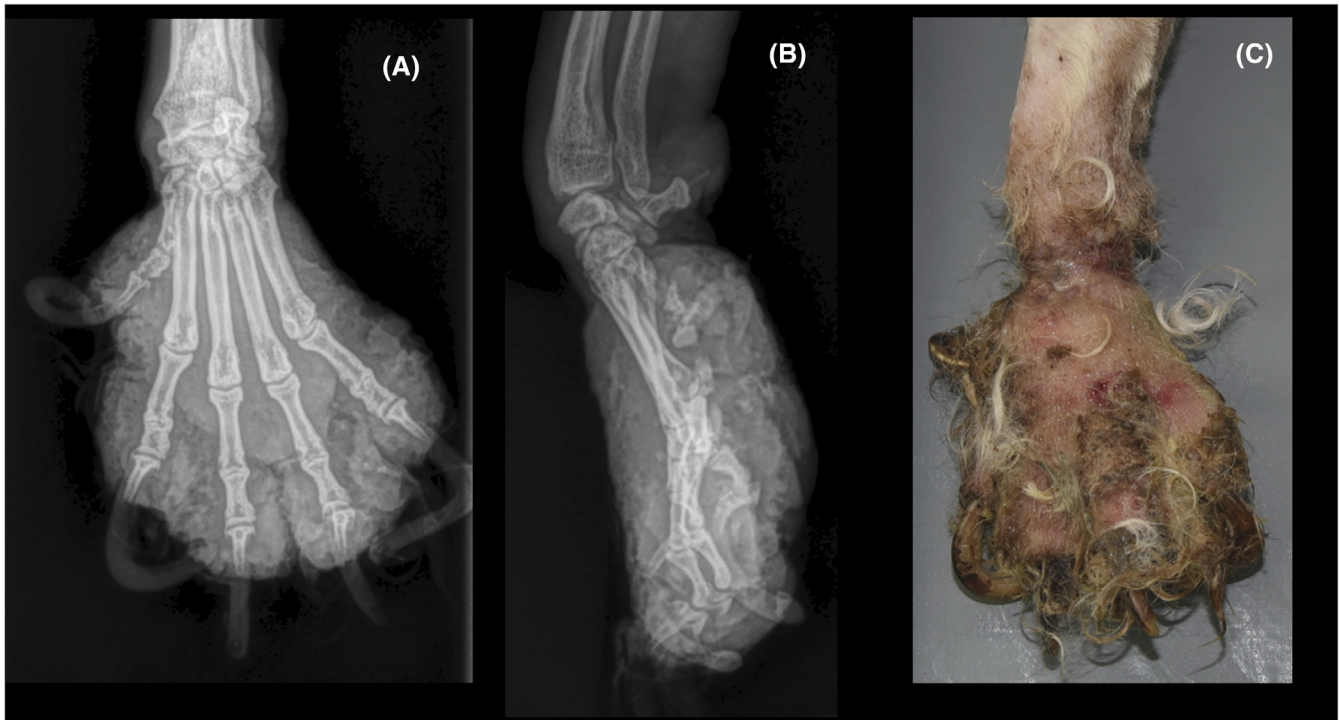


FIGURE 1 (A) Dorsopalmar and (B) lateral radiographic views and (C) dorsal photographic view of the left carpus in a 12-year-old poodle demonstrating hair matting and soft tissue swelling due to edema and congestion from decreased venous and lymphatic return, distal to the constrictive hair matting at the level of the carpometacarpal joint. The claws are severely elongated and curled. The matted hair has been removed on the photographic image (2.5 mAs, 86 kVp) [Color figure can be viewed at wileyonlinelibrary.com]

identification of the offending hair, exploration with removal of the hair, and curettage of any involved bone.¹³

Although the occurrence of a strangulating hair mat is reported in the veterinary literature as a medical finding in animal neglect cases, no radiographic features of strangulating hair mats have been described and the occurrence of osseous lesions associated with the soft tissue defect has not been reported.^{14–16} The objectives of this study were to describe the radiographic characteristics of chronic hair mat strangulation in dogs, to identify any clinical features to differentiate between dogs with soft tissue lesions only versus dogs with osseous changes, and to describe the clinical outcome in these dogs.

2 | METHODS

The study was a retrospective case series design. An electronic database of animal cruelty criminal cases presented to the American Society for the Prevention of Cruelty to Animals (ASPCA) Animal Hospital in New York City was searched for cases from October 2014 through February 2019 that included any version of the word “matting” or “strangulating” in the case description. Approval for the study was obtained from the ASPCA Executive Leadership Team and ASPCA Legal Division. The medical records for the identified cases were then retrieved and reviewed from the electronic medical record database of the ASPCA Animal Hospital in New York City. Dogs were included in the study if orthogonal radiographs of the anatomical areas of mat-

ted hair were obtained and if the admitting clinician described the matted hair as strangulating or constrictive. The decision for exclusion or inclusion of animals in the study was made by consensus opinion of an American College of Veterinary Radiology (ACVR)-certified veterinary radiologist (EW) and a forensic veterinarian (LN). The signalment, the forensic evaluation, and treatment outcome data were recorded by the forensic veterinarian (LN). Images were evaluated on a DICOM viewer (Osirix, Bernex, Switzerland) by the ACVR-certified veterinary radiologist (EW) and forensic veterinarian (LN). Observers were aware of the signalment and forensic evaluation at the time of image evaluation. Also based on a consensus opinion, the following radiographic features were recorded: soft tissue defect, bone atrophy, secondary fractures, bone deformation or remodeling, luxation or subluxation, focal bone lysis, diffuse or focal periostitis, regional osteopenia, and sequestrum. The use of these radiographic features was based on previously described radiographic findings in foreign body ischemic necrosis and radiographic changes of osteomyelitis.^{1,2}

3 | RESULTS

3.1 | Signalment and forensic presentation

Twenty-seven dogs met the criteria for inclusion in the study. Thirty cases of dogs with strangulating hair mats were identified. Three of the 30 cases were excluded because orthogonal radiographs were not



FIGURE 2 (A) Dorsoplantar and (B) lateral radiographic views of the left pes of a 2-year-old Shih Tzu with strangulating hair matting at the level of the metatarsal bones. A concave defect (arrow) and mild periostitis (arrowheads) are seen on the abaxial surface of the second metatarsal bone at the level of the constriction (2.5 mAs, 86 kVp)

available. All available imaging studies were acquired with a digital radiographic system (Canon Inc, EDR6A) using an extremity setting. The mAs and kVp values varied based on a radiographic technique chart and the thickness of the body part. A total of 43 strangulating hair mat lesions were identified in the 27 dogs. The mean age at presentation was 5.7 years (range 1-16 years). Five small-dog breed types with long hair were represented: 14 Shih Tzu-type, four poodle-type, three Yorkshire terrier-type, one Pekingese-type, and five Maltese-type dogs. Twelve dogs (44%) were female and 15 (55%) dogs were male. With the exception of three females, two males, and one dog of unrecorded status, all dogs were sexually intact at the time of initial examination. Four dogs were examined postmortem. In five of the 27 cases, digits or parts of digits were absent with exposure of proximal bone and soft tissue, indicating loss of the digit from ischemic necrosis with or without self-amputation. Of the 43 strangulating hair mats identified, two limbs were affected in seven dogs, four limbs in three dogs, and one limb in the remaining 17 dogs. In cases of a single strangulating lesion, the front or hind limb distribution was similar. The front limb was affected in eight and the hind limb was involved in nine of the 17 dogs with a single strangulating hair mat. The hind limbs were involved in three of seven dogs with two limb involvement and the fore limbs only in the remaining four dogs. The general condition on presentation was described as severe or extreme hair matting and as strangulating hair matting. Foreign material was not identified in the any of the

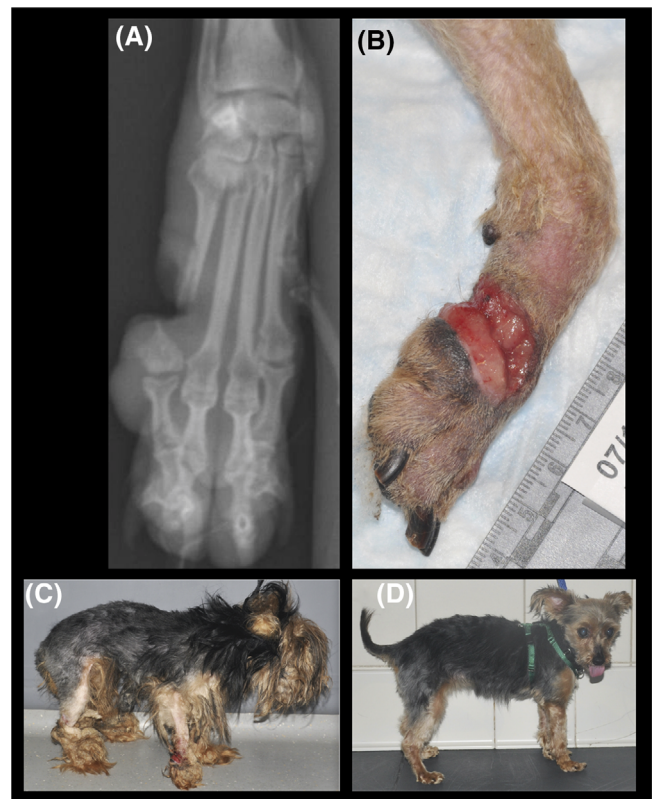


FIGURE 3 (A) Dorsopalmar radiographic view demonstrating atrophic bone and a complete defect in the distal fifth metacarpal bone and (B) a lateral photographic view following surgical debridement of a strangulating hair matting lesion, and (C) the admission photo of the 7-year-old Yorkshire Terrier with hair matting in all four limbs and (D) the patient following shaving of the hair mats, grooming, and healing of the surgically debrided constricting wound (2.5 mAs, 86 kVp) [Color figure can be viewed at wileyonlinelibrary.com]

constrictive lesions. No clinical features such as depth of the wound, estimated chronicity of the lesion, or lesion location on the limb were associated with the presence or absence of osseous changes on the radiographs.

3.2 | Histopathology results

In 19 of 27 cases, histopathology of the affected limb or limbs was available. In addition to the common feature of necrotizing and fibronecrotizing dermatitis, deep granulation tissue with embedded hair shafts was a common finding. Ischemic necrosis secondary to the clinically described strangulating wound was the most common feature. Other than hair shafts, no foreign bodies were identified in the constrictive soft tissue. None of the histological samples noted follicular drop out or atrophy as would be expected with chronic traction alopecia. Osteomyelitis was reported as a finding in two of eight cases (25%) of the histology samples that included bone. No bone cultures were performed. The chronicity of the soft tissue lesions, when estimated by the pathologist, ranged from 2 weeks to 2 months.

FIGURE 4 (A) Dorsopalmar and (B) lateral radiographic views of strangulating hair matting of the right carpus in a 3-year-old Shih Tzu. Carpometacarpal subluxation and a circumferential soft tissue defect (arrows) at the level of the proximal metacarpal bones are present. Additionally, subluxation in the fifth metacarpophalangeal joint and fifth metacarpal bone remodeling are present (2.5 mAs, 86 kVp)

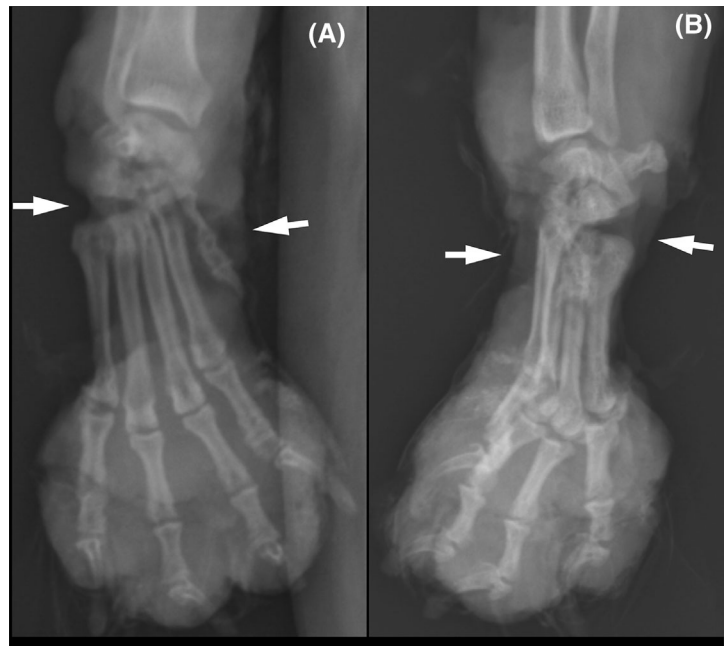
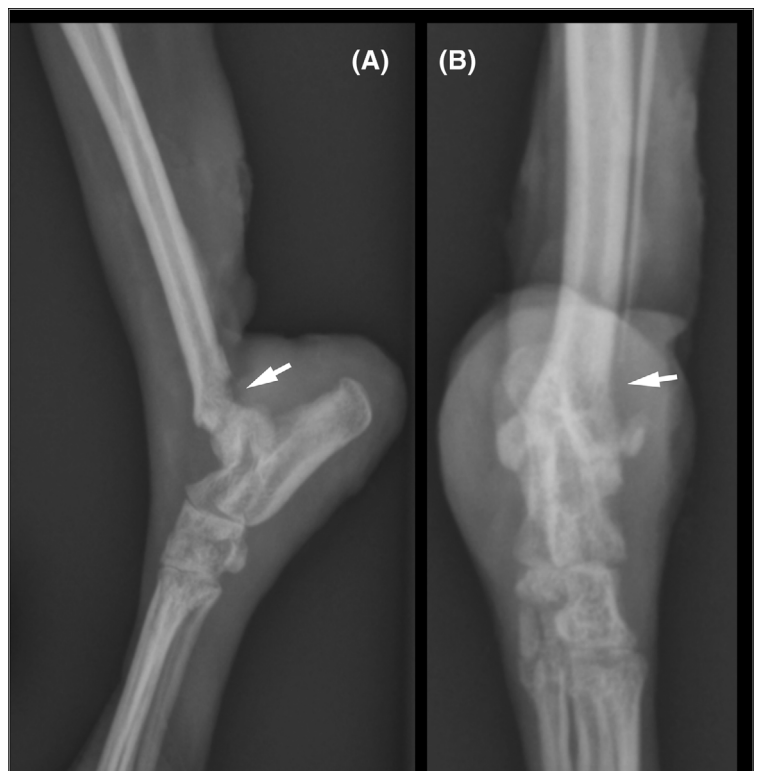


FIGURE 5 (A) Lateral and (B) dorsoplantar radiographic views of the left tarsus in a 10-year-old poodle that demonstrates osseous defects in the distal fibula and caudodistal tibia (arrows) and caudolateral soft tissue defect at the level of the strangulating hair matting (2.5 mAs, 86 kVp)

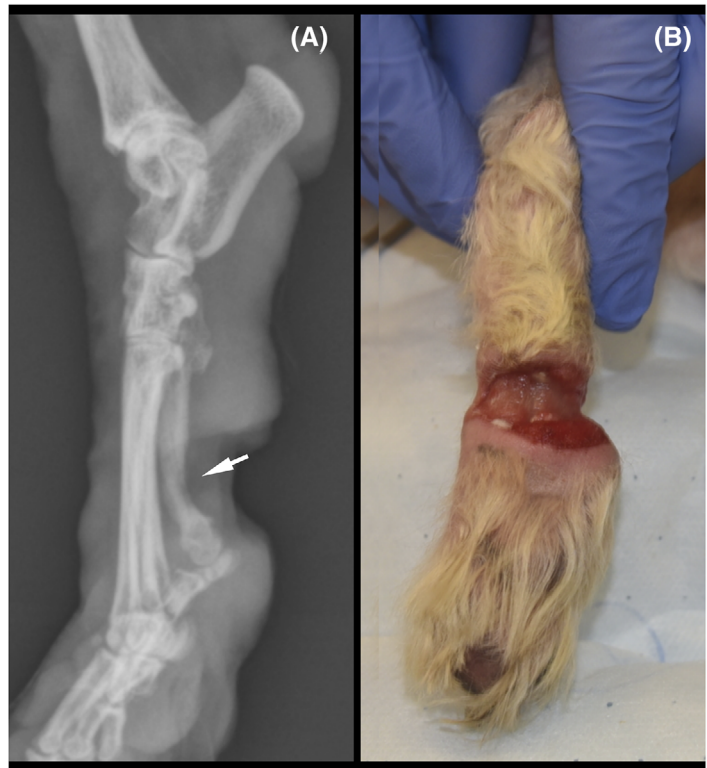


3.3 | Radiographic features

In 43 limbs from 27 dogs, a circumferential or focal soft tissue defect at the level of the metacarpal bones, metatarsal bones, distal antebrachium, or distal crus was radiographically identified (Figures 1A-C); however, none of the lesions were present proximal to the elbow or sti-

ple. In nine of the 43 limbs, focal decreased size of the bone or bone atrophy at the level of the constriction was identified. A change in the shape of the bone or bone remodeling at the level of the constriction was noted in four of the 43 limbs (Figures 2A and 2B). Complete defects in the bone at the site of bone atrophy or constrictive soft tissue lesions were present in seven of the limbs (Figures 3A-D). Fractures of bone were not observed in any case. Bone distal to the

FIGURE 6 (A) Lateral radiographic view and (B) a photographic image following shaving of a constrictive lesion secondary to strangulating hair matting in the metatarsus of a 6-year-old Maltese. A remodeled second metatarsal bone (arrow) and metatarsophalangeal subluxation are radiographically identified at the level of the constrictive lesion. An abrupt well-delineated deep ulcer lined by granulation tissue circumferentially encircling the metatarsus is accompanied by moderate to severe edema of the distal pes (2.5 mAs, 86 kVp) [Color figure can be viewed at wileyonlinelibrary.com]



constriction was complete absence of bone distal to the constriction was present in 9 limbs and focal bone lysis with a short transition zone was present in 6 limbs. Mild focal periostitis adjacent to the constrictive lesion was identified in five limbs; however, diffuse periostitis was not seen in any of the 43 limbs. In all four cases of joint subluxation (Figures 4A and 4B), the constrictive lesion occurred at the level of the joint: one middle carpal, one carpometacarpal, one metacarpophalangeal, and one tarsocrural. Osteopenia, noted in eight of the limbs, was generalized, consistent with disuse and was not local or confined to the bones at the constrictive site as would be expected with osteomyelitis. In two cases of osteomyelitis, as identified by the pathologist, radiographic signs included a complete absence of digits distal to the constriction, joint swelling, and joint subluxation. Radiographic features of diffuse periostitis, regional osteopenia, cortical loss, or endosteal scalloping were not seen in these two cases. A sequestrum was not identified in any of the 43 limbs. The osteolytic changes in this case series were most consistent with ischemic necrosis from the circumferential pressure of the constrictive matted hair (Figures 5A and 5B).

3.4 | Treatment outcome and case disposition

In two cases, the strangulating hair mat resulted in self-amputation. Clinical amputation, due to tissue necrosis and devitalization of the limb distal to the strangulating wound, was required in 11 (47%) of the live animal cases that were not self-amputating. Medical management, including surgical debridement (Figures 6A and 6B), was appropriate in the remaining 12 live animal cases.

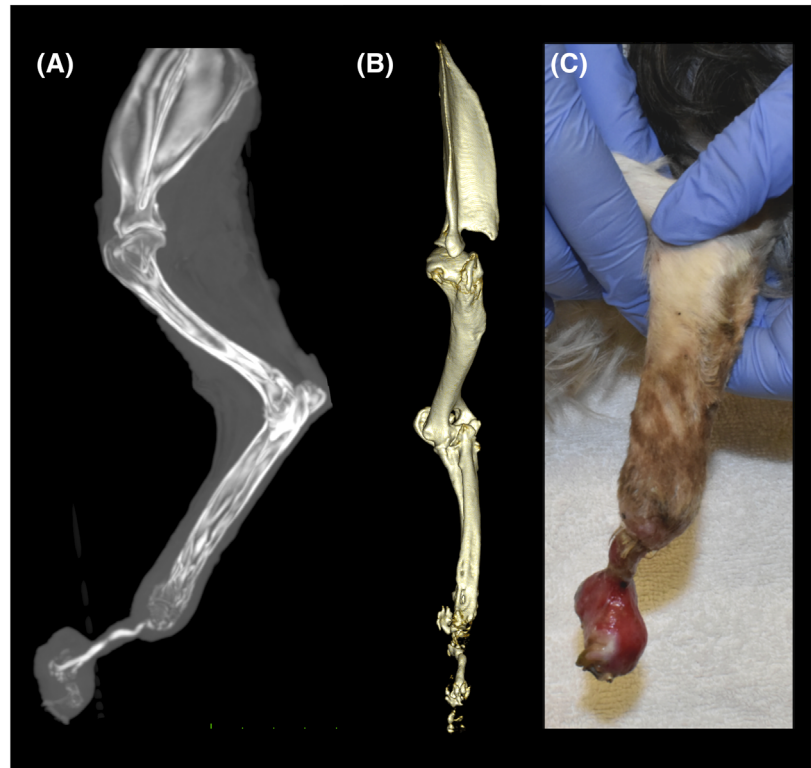
4 | DISCUSSION

Dogs presenting with strangulating hair mats can have osseous changes at the site of constriction secondary to ischemic necrosis. The osseous changes identified on this study at the site of hair constriction included complete defects in the bone, bone atrophy, bone remodeling, regional periostitis, subluxation, and generalized osteopenia of the affected limb. The circumferential soft tissue defects associated with strangulating hair mats and the associated osseous lesions were confined to the distal extremities in all dogs with a similar distribution between hind and fore limbs. No strangulating lesions were seen proximal to the stifle or elbow. All dogs of this study were characterized as small breed and the Shih Tzu-type breed was overrepresented. The preponderance of the Shih Tzu-type dog may represent the popularity of this small breed in a large metropolitan population or increased susceptibility of this breed type to severe and strangulating hair matting. All of the dog breed types represented in the study—Shih Tzu, Maltese, poodle, Pekingese, and Yorkshire terrier—have a hair cycle with a prolonged growth phase (anagen phase) resulting in a long hair coat distinguished from dogs with fur that have a shorter growth phase.¹⁴

Absence of histopathology in all limbs examined is a potential limitation of this study. Additionally, some dogs presenting for strangulating hair mats were excluded from the study because orthogonal radiographs were not obtained. Studies on a population with a greater diversity of dog breed types might help determine any breed or breed-type characteristics predisposing dogs to strangulating hair matting.

Severe hair matting is a common medical finding in cases of animal neglect, a form of animal maltreatment in which there is a lack of care provided to the animal. Radiographic soft tissue features of

FIGURE 7 (A) Sagittal maximum intensity projection (MIP) and (B) a cranial view of three-dimensional volume rendering of the amputated limb of a dog with chronic strangulating hair matting at the level of the carpus resulting in bone atrophy and near complete loss of the carpal bones, the metacarpal bones, and the phalanges, and (C) photograph of the amputated limb. Postprocessing maximum intensity projection (MIP) and three-dimensional volume rendering performed with OsiriX software version 11.0.3 (Pixmeo, Geneva, Switzerland) (Toshiba Aquilion, Tustin, CA; multislice, helical, 1-mm slice, 120 kVp, tube current = 200 mA, image matrix size = 512 × 512, soft tissue algorithm) [Color figure can be viewed at wileyonlinelibrary.com]



strangulating hair mats have occasionally been reported and are generally known by veterinarians in forensic science.^{15,16} However, veterinary radiologists and general practice veterinarians may be unaware of the potential osseous changes associated with this form of animal neglect. A soft tissue defect or circumferential constrictive soft tissue lesion was radiographically identified at the site of hair matting in all limbs evaluated in this case series; however, clinical features of wound depth, wound location, or estimated wound duration were not able to predict the presence or absence of osseous lesions. In absence of clinical features that would predict an osseous lesion, orthogonal radiography of all strangulating hair mats is advised to direct treatment options and predict clinical outcomes or function of the limb. Osseous lesions or bone remodeling, bone atrophy, and osseous defects were present at the site of hair matting in the majority of the limbs evaluated. When joint subluxation occurred, the constrictive lesion was at the level of the joint. The radiographic features identified in bone were most consistent with ischemic necrosis resulting from constriction by a circumferential hair mat (Figures 7A and 7B). Although radiographic studies are not known to be sensitive for detection of acute osteomyelitis, typical radiographic features associated with chronic osteomyelitis, such as sequestrum, periostitis, and regional osteopenia, were not identified in any of the limbs. Defects in bone surrounded by constrictive strangulating hair mats should be considered the result of ischemic necrosis rather than direct trauma or osteomyelitis. The descriptive terms of bone atrophy and bone lysis may be more apt than referring to such defects as fracture.

In conclusion, findings from this study indicated that animals presenting with hair matting and strangulating hair matting may have concurrent osseous changes such as bone remodeling, bone atrophy, bone

lysis, and occasionally joint subluxation. This study did not identify clinical features to differentiate between dogs with and without osseous lesions secondary to strangulating hair mats. Therefore, orthogonal radiography would be advised in all dogs presenting with clinically identified strangulating hair mats.

LIST OF AUTHOR CONTRIBUTIONS

Category 1

- (a) Conception and Design: Watson, Niestat
- (b) Acquisition of Data: Watson, Niestat
- (c) Analysis and Interpretation of Data: Watson, Niestat

Category 2

- (a) Drafting the Article: Watson, Niestat
- (b) Revising Article for Intellectual Content: Watson, Niestat

Category 3

- (a) Final Approval of the Completed Article: Watson, Niestat

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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