JOURNAL OF VETERINARY FORENSIC SCIENCES

Research and analysis of wild and domestic species

JVFS.NET | DOI: 10.32473/JVFS.2.1.130161 | VOLUME 2 (2023), ISSUE 1
RECEIVED 22 DEC 2021 | ACCEPTED 15 DEC 2022 | PUBLISHED ONLINE 6 JUN 2023

CASE REPORT

Forensic evaluation of a dog with an embedded chain collar and corresponding wound age estimation

Danielle R Godard[1] MSc DVM, Sean P McDonough[2] DVM PhD DACVP, Shelagh Copeland[3] MVetSc DVM

ABSTRACT: The body of a young intact male dog was presented with an embedded chain collar around his neck as possible evidence in proceedings under the *Criminal Code* of Canada. A photographic record was made for court purposes. The circumference of the collar versus the adjacent unaffected neck was measured, showing the collar to be 15% shorter than was necessary to be compatible with non-injury to the dog while alive. Granulation tissue and fibrosis were grossly and histologically evaluated to help estimate the age of the wound. The granulation tissue at its deepest point was 2.0 cm. Considering granulation tissue begins formation 3–5 days post-injury and forms at a rate of 0.4–1.0 mm per day, the initial age of the wound was estimated at 23–55 days; however, given the re-epithelialization and fibrous strength of the affected tissue as well as the presence of haired skin around the links, the time estimate was determined to be more likely in the order of 4–6 months. Findings were later used in court as evidence in the charge of unnecessary pain, suffering and injury to an animal under Section 445.1(1)(a) of the *Criminal Code*. Testimony at the trial supported the estimated age of the wound. The owner was found guilty, fined Can$1000, placed on probation for two years, and prohibited for life from owning animals.

KEYWORDS: veterinary forensic sciences, animal cruelty, animal neglect, animal abuse investigation, canine, embedded collar, wound dating

When collars are placed on young animals and not readjusted to accommodate growth, the collar becomes embedded within the neck tissue, which can cause neck disfigurement, significant pain, and pressure necrosis (Merck et al. 2013, Reisman 2013). The compression of the collar about the neck can cause tissue swelling and edema from vessel constriction and prevent normal head movement (Merck et al. 2013). Septicemia may result from associated bacterial infection of the skin and underlying tissue (Merck et al. 2013). Animals may also have difficulty swallowing, leading to malnutrition, starvation, and dehydration (Merck et al. 2013).

Embedded restraint devices are a form of animal neglect. Neglect cases comprised approximately 43% of 271 criminal cases in one study (McEwan 2012) and 30% of reported animal abuse cases in another (Bradley-Siemens 2018). To help assess the degree and time of suffering, enforcement officers usually want to know the length of time the collar was causing a wound. The wounds of embedded collars are distinctive in that the wound is caused by pressure necrosis versus incision or laceration. On review of online resources, including PubMed and the library of the University of Saskatchewan, no information was found on embedded restraints in human forensic pathology or research on the pathology of embedded restraints. The closest analogy may be pressure sores in people and animals with limited mobility. Future research is unlikely, given animal welfare concerns.

To our knowledge, this is the first peer-reviewed case report specific to embedded collars. The purpose of this case study is to take the general veterinary practitioner or pathologist through the entirety of an embedded-collar

[1] Office of the Chief Veterinarian, Manitoba Agriculture, Food and Rural Development, 545 University Crescent, Winnipeg, Manitoba R3T 5S6 CAN (former student position)
[2] Department of Biomedical Sciences, Cornell University, College of Veterinary Medicine, T8 008A Veterinary Research Tower, Ithaca, NY 14853-6401 USA
[3] Prairie Diagnostic Services, University of Saskatchewan, 52 Campus Drive, Saskatoon, Saskatchewan S7N 5B4 CAN
Corresponding author: Danielle Godard, drgodard204@gmail.com, 608-332-2163

case: detailing notable findings on necropsy, describing histological details, providing an estimation of wound age (including associated limitations), summarizing the legal proceedings, and highlighting investigation methods that can be used in the live animal. It is the intent that the current case helps others evaluate, document, and substantiate similar cases of animal abuse specific to embedded collars.

Case Description

History

The body of an approximately two-year-old intact male dog was presented to the Veterinary Diagnostic Services Laboratory (VDSL) at Manitoba Agriculture, Food and Rural Development by a detachment of the Royal Canadian Mounted Police (RCMP). The owner had willingly surrendered the dog to the city for euthanasia. The city respondent in the case noted a foul odor and several injuries on the dog, including substantial injury to the neck. Due to concern over the state of the animal, the RCMP was contacted for further investigation prior to euthanasia. The RCMP assessed the dog and found it to have an offensive odor and a severely embedded chain collar around its neck with fur that appeared to be partially grown over the links of the chain. Due to the severity of the problem, the animal was euthanized by a gunshot to the head, resulting in instantaneous death. The body was kept outdoors in a cool place (−7 to 11 °C) until it could be submitted, four days later, to the VDSL for detailed investigation as legal action for cruelty and neglect was being pursued.

Gross Necropsy

Upon presentation for necropsy, the dog was moderately autolyzed with partial freezing of the skin in the head region, most noticeably the lips and eyelids, confirming the dog was held in freezing temperatures. There were no supportive signs of significant desiccation. The body weighed 42 kg with the chain. The ribs and dorsal lumbar vertebrae were easily palpated, and the animal had a noticeable waist and abdominal tuck. The dog was double-coated with long guard hairs and a thick undercoat typical of a northern breed. The chain links around the dog's neck were not easily visible due to the volume of matted hair, dried brown exudate, scabs, mud, and multifocal deep groove-like ulcers caused by the chain collar in the skin; the hair about the neck was clipped to visualize the area (**FIGURE 1**) better.

The neck's skin in the collar region showed deep ulcerations. Within the ulcerated skin were moderately numerous small fly eggs; whether these were deposited antemortem or postmortem is unknown. Granulation tissue and overlying fibrosis to the epidermis were 1.5 cm in depth in the area. On the dorsum of the neck, three links

FIGURE 1—The dorsal neck's clipped (no. 40 clipper) surface with embedded chain (rostral left, caudal right). The chain is difficult to visualize in this projection. The area shows dried brown exudate, scabs, mud and multifocal deep groove-like ulcers caused by the chain collar in the skin.

FIGURE 2—Dorsum of the neck showing three embedded links (rostral right, caudal left). Note that the central link in the image (vertical in orientation) contains a skin bridge that has re-epithelialized and regrown hair.

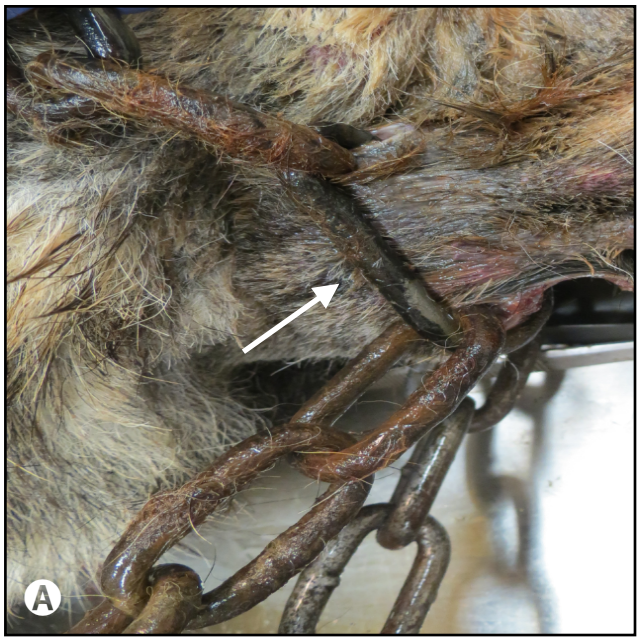
were partially covered by skin (**FIGURE 2**). The skin was firm overlying two of the links, and the links could not be removed without incising the tissue. The third link of the group was covered by less mature tissue, which could be pulled apart manually to free the embedded portion of the

link. On the incision of the dorsally embedded links, there was scant fluid. The links on the neck's right lateral side caused deep ulcerated grooves and skin bridges (**FIGURE 3**). On the left side of the neck, the chain was slightly looser though the links still caused shallow erosions and skin reddening.

FIGURE 3—Right side of the neck (rostral left, caudal right) with ulcerated and embedded links similar to FIGURE 2 in the re-organization of near-normal skin within the loop of the chain link.

On the ventral neck, a larger link was also covered on one side by firm re-epithelialized tissue that could not be removed without incising the skin. In this region, the skin was folded and bunched beside the link. Upon incision, the link was noted to be surrounded by a small amount of turbid brown fluid with a few small gritty metal-like flakes. The embedded portion of the link and fluid were enclosed in red granulation tissue (**FIGURE 4**). The depth of the granulation tissue and overlying fibrosis to the epidermal surface was 1.5 cm in this area. Following removal, the link was found to be a carabiner 5.9 cm in length, 2.0 cm at its narrowest point and 2.9 cm at its widest point, with metal having a diameter of 0.5 cm (**FIGURE 4**). Comparatively, other links making up the chain collar were 4.3 cm in length by 2.3 cm in width, with the diameter of metal being 0.5 cm.

The circumference of the shaved neck, immediately adjacent to the chain collar, was measured at 55 cm. With all tissues surrounding the embedded links incised, the chain collar was removed by cutting two links with a commercial bolt cutter. The length of the chain collar around the neck was measured at 48 cm as reassembled, which was 7 cm (15%) shorter than necessary to be compatible with non-injury to the dog while alive. As is



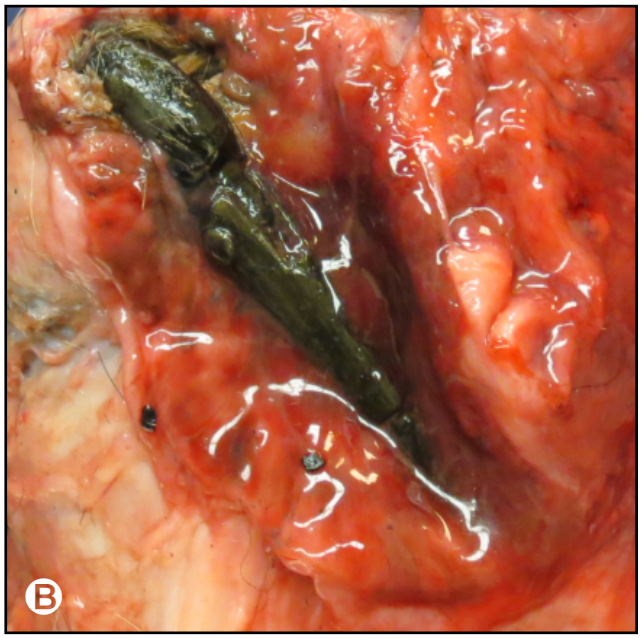


FIGURE 4—A) Ventral view of the neck (rostral right, caudal left) with embedded carabiner (arrow). B) Subcutaneous side of embedded carabiner after removal of the flap of skin involved.

typical, the circumference of the chain would have needed to be longer than that to follow general guidelines on the use of collars (HSUS 2022). The total weight of the chain, including the part around the neck, weighed 2.5 kg.

The skin enveloping the embedded links and where the collar had caused ulceration was incised in a strip and fixed in formalin. When the affected skin was excised for histology, a few broader areas of granulation tissue and fibrosis measuring 2.0 cm in depth were found.

Further evaluation of the animal showed that the intermandibular space was moderately edematous, and the prescapular and axillary lymph nodes were red, moderately enlarged and moist. Minimal body fat stores were present. Subcutaneous tissues were moderately tacky. The stomach and small intestine were empty; the colon contained a moderate amount of dry fecal material primarily composed of hair with a small amount of grass.

The growth plates had closed in the femur and were near complete closure in the distal radius. The teeth were white and sharp. The size of the dog and the characteristics shown in the growth plates and teeth were features consistent with the animal being a young adult, approximately 12–18 months of age (Dyce et al. 2010).

Histologic Findings

Standard wax embedding techniques were applied to process tissue samples, and 7-µm thick slices were cut and stained with hematoxylin and eosin (H&E) for microscopic slide evaluation.

Histologically, the skin adjacent to the areas of ulceration had mild perivascular chronic dermatitis, moderate fibrosis, mild apocrine adenitis and severe epidermal hyperplasia and hyperkeratosis with occasional mild parakeratosis and rare intracorneal desiccated pustules (**FIGURE 5**).

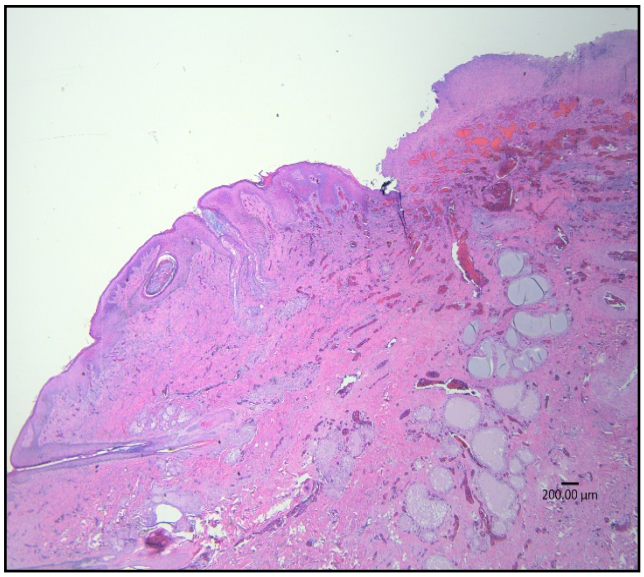


FIGURE 5—Histopathologic examination of the epidermal junction with the ulcerated area showing epidermal hyperplasia, apocrine dilation, adenitis, and fibrosis. Hematoxylin and eosin. 20×.

Ulcerated areas were generally lined by granulation tissue consisting of proliferating vessels mainly perpendicular to the ulcerated surface and supported by a loose to moderately dense stroma of fibroblasts and fine collagen fibers usually lying perpendicular to the vessels. Minute sprouting capillaries followed the latter, occasionally thrombosed, and capped by a surface layer of necrotic cellular debris, fibrin, foreign material and cocci. In some areas, the granulation tissue was compressed, distorted and hemorrhagic. The tissue adjacent to the granulation tissue had maturing fibrosis of variable thickness (**FIGURE 6**).

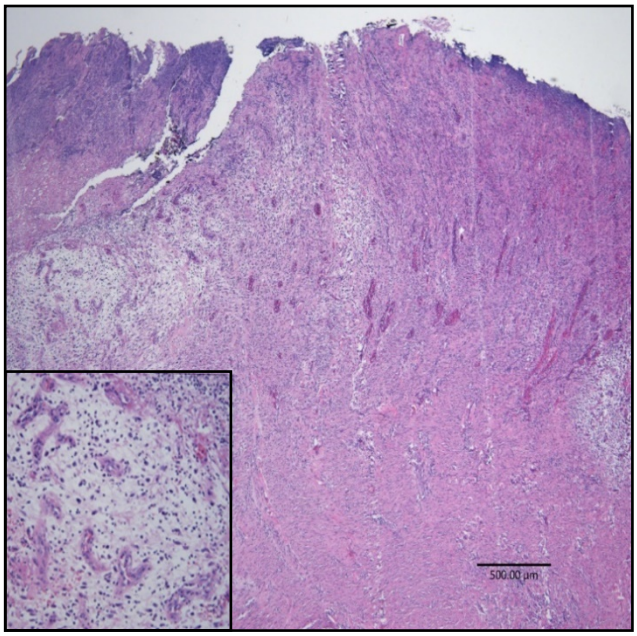


FIGURE 6—Histopathologic examination of the ulcerated area showing granulation tissue with surface debris, vascular proliferation and fibroplasia. Hematoxylin and eosin. 40×. **Inset: magnification of sprouting capillaries.** Hematoxylin and eosin. 200×.

Inflammation within the ulcerated tissue was a mixture of neutrophils, macrophages, eosinophils, mast cells, lymphocytes and plasma cells, with neutrophils most numerous near the ulcerated surface. Brown granular material was occasionally contained within macrophages. In those regions of the ulcerated tissue where the chain links exerted more direct pressure, the adjacent tissue was also more mature, consisting of fewer vessels, larger collagen fibers, often in bundles, and usually with no distinct sprouting capillaries.

Denser fibrosis with mixed inflammation extended down into and through the panniculus, which had moderately thickened arteries, and lymphatics and myocytic degeneration.

In areas where a portion of a link was wholly embedded in subcutaneous tissue, the metal was surrounded by pink light amorphous material with moderate leukocytic debris and brown particulate to crystalline debris. The surrounding tissue had a frond-like stroma projecting into the lumen with capillary proliferation, mixed leukocytic

infiltration, fibroblast proliferation and collagen deposition similar to that described for the granulation tissue of ulcers (**FIGURE 7**).

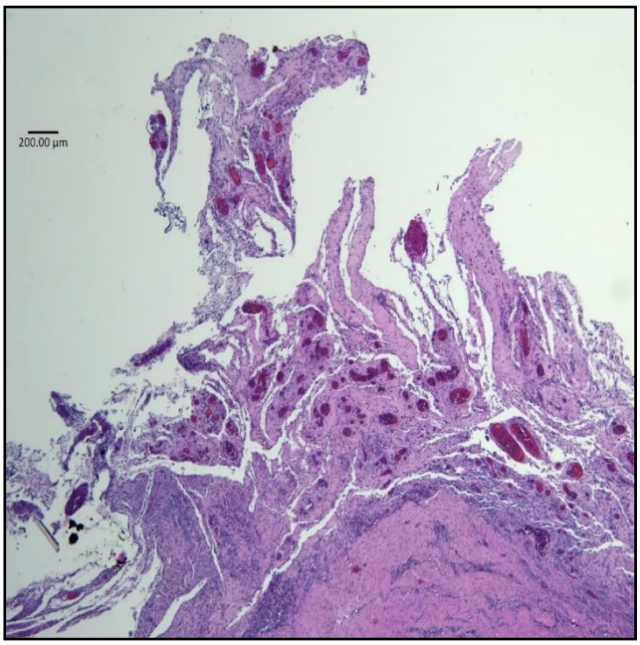


FIGURE 7—Histopathologic examination of tissue around embedded links shows a frond-like stroma with capillary proliferation.
Hematoxylin and eosin. 40×.

Wound Age Estimation and Synopsis

Though histology of the ulcerated area was evaluated in this case, it did not significantly refine the age estimation of the wound that resulted from the embedded collar. The gross findings were most significant in gauging the duration of injury to this animal. Granulation tissue generally forms in 3–5 days (Hosgood 2006, MacPhail 2013), growing at approximately 0.4–1.0 mm per day (MacPhail 2013) and slowing during aging to approximately 1.0 cm per month. Therefore the 2.0-cm depth of granulation tissue and fibrosis gave an initial wound-age estimation of approximately 23–55 days. However, re-epithelialization and the tensile strength of the fibrous tissue around the embedded links supported a more extended period. Unimpaired re-epithelialization begins days after injury, taking up to 3–4 weeks or longer; the duration is lengthened if factors impairing proper wound healing are present (Ackermann 2012). In this case, a large foreign body, such as the metal chain, would have interfered with proper wound healing (SP McDonough, personal communication) and timely re-epithelialization. Remodeling of immature connective tissue to mature connective tissue in a healing wound begins approximately 3–4 weeks after injury but can potentially take up to 2 years or more to complete (Ackermann 2012). Generally, the thickness of the scar tissue around an embedded collar tends to stabilize around 1–2 months, but the amount of time a collar is embedded in the neck may be much longer (SP McDonough, personal communication). The incorporation of the chain links beneath haired skin is highly unusual. Hair follicles can regenerate in re-epithelialized tissue, depending on the extent of skin damage (Ackermann 2012, MacPhail 2013). Such a change would likely have occurred only after a considerable period, 4–6 months after initial ulceration (SP McDonough, personal communication). The dog likely suffered significant pain from the irritation induced by the chain and the secondary infection (SP McDonough, personal communication). The dog was underweight and dehydrated. As no other abnormalities were found except for the embedded collar, it suggested that the dog was not offered food and water, was too painful to swallow, was inappetent due to the effects of chronic inflammation, or a combination of the above.

Legal Conclusion

Findings were later used in court as evidence in the charge of unnecessary pain, suffering and injury to an animal under Section 445.1(1)(a) of the *Criminal Code* of Canada (Causing…2020). In statements to the RCMP, presented in legal proceedings from the court trial (NCPAC 2020), the defendant acknowledged that the dog was only fed occasionally and was kept chained in the backyard. The defendant further admitted to being alerted to an issue with the collar being too tight that winter, yet it was not until May that the dog was surrendered to the city for euthanasia. The testimony presented at the trial supported that the dog was underfed and neglected and directly supported the estimation that the dog collar was likely to have been embedded for a prolonged 4–6-month period, as stated in the final forensics report. The owner was found guilty, fined Can$1000, put on a two-year probation, and prohibited for life from possessing, having custody or control of, or residing in the same premises as an animal (NCPAC 2020, Government of Canada 2020).

Discussion

Embedded collars are considered a form of neglect and non-accidental physical injury that can qualify for prosecution in jurisdictions with animal protection laws (Merck et al. 2013, Munro and Thrusfield 2001). Animal cruelty investigations can benefit from support provided through veterinary forensics, which can document, characterize, and provide an age estimation of the wound inflicted by the embedded collar and the length of time an animal suffered.

It is essential to highlight that the aging of wounds is difficult and inexact, as demonstrated in the current case where re-epithelization and fibrosis were also present, along with ongoing pressure necrosis. The information provided in veterinary forensic textbooks for estimating the length of

time a collar has been embedded is based on the length of time for granulation tissue to appear and the rate at which it grows (Hosgood 2006, Pavletic 2010, White 1999, Souza and Mann 2011, MacPhail 2013, Reisman 2013). The length of time it takes for granulation tissue to form, however, can vary by location of the injury, size of the wound, type of wound, tissue type affected, age and health of the animal, presence of infection, myiasis (maggot infestation), nutritional and immune states, and the species of animal in question (Hosgood 2006, Bohling and Henderson 2006, Munro and Munro 2008). For instance, for second intention cutaneous healing, the mean time for dogs to complete granulation is 7.5 days, as opposed to cats which take an average of more than 19 days (Bohling and Henderson 2006) and therefore have a much slower healing rate. Furthermore, cats produce significantly less granulation tissue than dogs in second-intention healing (Bohling et al. 2004). Factors to consider related to granulation tissue formation include foreign material in wounds, which results in inflammation that interferes with normal wound healing (MacPhail 2013), and pressure variation along the length of the collar. Sustained pressure can lead to occlusion of blood vessels resulting in ischemia and necrosis (McGavin and Zachary 2012). Pressure is the primary cause of ulceration in embedded collar cases. The degree of pressure can vary along the length of the collar and so affect the depth of the ulcer and, consequently, the depth of granulation tissue and fibrosis. Wounds along the ventral aspect of the neck are typical in animals with embedded collars due to the animal pulling forward against its restraint (Reisman 2013). As seen in this case, the carabiner on the ventrum (**FIGURE 4**) was the most embedded and covered entirely by the skin. The heavy chain used to restrain the animal was one continuous piece of chain attached to the loop of the carabiner. The point of attachment of the restraint chain served as the area of highest pressure, causing pressure necrosis. The further injury likely resulted from the decreased rotation of the collar about the neck due to the attachment of the tether to a fixed point. The factors above highlight that when attempting to date a wound, it is critical to remember that the uncertainty introduced by biological variability permits a *probable*, but never a definite, conclusion (Saukko and Knight 2004).

The current investigation focused on a deceased animal; however, similar methods to those described in this case investigation can be used when veterinarians are presented with live animals. Documentation should include initial photographs and circumferential measurements of the neck at the site of the embedded collar and an adjacent site of the unaffected neck (Bradley-Siemens et al. 2018, Merck et al. 2013). Furthermore, the collar's weight should be documented after removal, often requiring general anesthesia (Merck et al. 2013). The collar should be cut away, rather than untied or unbuckled, using gloved hands to preserve trace evidence (such as fingerprints that may be used to identify the abuser), and the collar should be retained for legal purposes (Bradley-Siemens et al. 2018, Merck et al. 2013). The width and depth of the wound should be detailed, and a wedge-shaped biopsy from the haired surface to the underlying healthy bleeding tissue should be collected to help determine the thickness of the scar and, hence, the age of the wound (Merck et al. 2013, Reisman 2013). Dating of injury from an embedded collar can be further aided by myiasis, often present in cases of embedded collars, with the stage of insect development helping to establish a timeline for the injury (Bradley-Siemens et al. 2018, Merck et al. 2013). No set protocol for ongoing evaluation of the healing stages is known; however, if the wound is left open for second-intention healing, the area could be monitored with serial evidential photographs taken up until the point the wound is covered by the epidermis and the hair starts to regrow, though hair growth may be limited or not occur depending on the degree of injury. The evaluation of the depth of the granulation tissue from the biopsy, maggot development, and detailed monitoring of time to return of pre-excisional skin characteristics can determine the timeframe surrounding collar embedding and tissue healing in a live animal.

Conclusion

The current case study outlined the detailed investigation of a dog with an embedded collar where legal action for cruelty and neglect was being pursued. It showed that necropsy findings and generalized wound age estimation could be paramount in emphasizing neglect and could be used to support ancillary evidence and testimony during an embedded collar abuse trial. It further highlighted that, while granulation tissue can be used to estimate the timeframe, it is necessary to be aware that establishing how long a dog collar has been embedded is an inexact science, with multiple factors influencing the ability to provide a truly accurate determination. Finally, the current case study detailed that embedded collar investigations are not limited to deceased animals. As outlined in this article, similar investigation methods are recommended to be transposed to live animal cases.

Acknowledgments

This project was made possible with support from the Manitoba Student Temporary Employment Program and the Department of Agriculture Food and Rural Development. The authors would also like to acknowledge Drs. Terry Whiting and Rosemary Postey for their encouragement and comments on earlier report drafts.

Disclosures

The authors declare no conflict of interest.

References

Ackermann MR. 2012. Inflammation and healing. *In:* McGavin DM, Zachary JF, editors. Pathological basis of veterinary disease. 5th ed. St. Louis (MO): Mosby Elsevier. p. 89–135.

Bradley-Siemens N, Brower AI, Reisman R. 2018. Neglect. *In:* Brooks JW, editor. Veterinary forensic pathology. Vol. 2. Cham (Switzerland): Springer. p. 37–65. doi:10.1007/978-3-319-67175-8.

Bohling MW, Henderson RA. 2006. Differences in cutaneous wound healing between dogs and cats. *Vet Clin Small Anim*. 36:687–92. doi: 10.1016/j.cvsm.2006.02.001.

Bohling MW, Henderson RA, Swaim SF, Kincaid SA, Wright JC. 2004. Cutaneous wound healing in the cat: a microscopic description and comparison with cutaneous wound healing in the dog. *Vet Surg*. 33:579–87. doi:10.1111/j.1532-950X.2004.04081.x.

Dyce KM, Sack WO, Wensing CJG. 2010. Textbook of veterinary anatomy. 4th ed. St. Louis (MO): Saunders Elsevier.

Causing unnecessary suffering. 2020 [accessed 2021 Dec 12]. *Criminal Code*, RSC 1985, c. C-46, s. 445.1(1)(a). laws-lois.justice.gc.ca.

Hosgood G. 2006. Stages of wound healing and their clinical relevance. *Vet Clin N Am-Small*. 36:667–85. doi:10.1016/j.cvsm.2006.02.006.

(HSUS) Humane Society of the United States. 2022 [accessed 2022 May 19]. Which type of dog collar is best for your dog? Washington (DC): HSUS. humanesociety.org/resources/dog-collars.

MacPhail CM. 2013. Surgery of the integumentary system. *In:* Fossum TW, editor. Small animal surgery. 4th ed. St. Louis (MO): Mosby. p. 190–288.

May ER. 2016. Pyoderma. *In:* Tilley LP, Smith Jr FWK, editors. Blackwell's five-minute veterinary consult: canine and feline. 6th ed. Ames (IA): Wiley-Blackwell. p. 1136–7.

McEwen BJ. 2012. Trends in domestic animal medico-legal pathology cases submitted to a veterinary diagnostic laboratory 1998–2010. Poster session presented at: International Veterinary Forensic Sciences Association Meeting; 2011 May 2–4; Orlando, FL. *J Forensic Sci*. 57(5):1231–3. doi:10.1111/j.1556-4029.2012.02123.x.

Merck MD, Miller DM, Reisman RW. 2013. Patterns of non-accidental injury: neglect. *In:* Merck MD, editor. Veterinary forensics animal cruelty investigations. 2nd ed. Oxford (UK): John Wiley & Sons, Inc. p. 201–21. doi:10.1002/9780470344583.ch11.

Munro HMC, Thrusfield MV. 2001. 'Battered pets': non-accidental physical injuries found in dogs and cats. *J of Small Anim Pract*. 42(6):279–90. doi:10.1111/j.1748-5827.2001.tb02041.x.

Munro R, Munro HMC. 2008. Animal abuse and unlawful killing: forensic veterinary pathology. Edinburgh (UK): Saunders Elsevier. doi:10.1016/B978-0-7020-2878-6.X5001-6.

(NCPAC) National Centre for the Prosecution of Animal Cruelty Case Law Database. 2020 [accessed 2020 Jul 31]. R v Mader, 2016 MBPC. [place unknown] (CA): NCPAC. caselaw.ncpac.ca/r-v-mader-2016-mbpc.

Pavletic MM. 2010. Atlas of small animal wound management and reconstructive surgery. 3rd ed. Ames (IA): Wiley-Blackwell.

Reisman RW. 2013. Veterinary forensics: medical evaluation of abused live animals. *In:* Miller L, Zawistowki S, editors. Shelter medicine for veterinarians and staff. 2nd ed. Ames (IA): John Wiley & Sons, Inc. p. 383–406. doi:10.1002/9781119421511.ch23.

Saukko P, Knight B. 2004. Knight's forensic pathology. 3rd ed. London (UK): Hodder Arnold. doi:10.1201/b13642.

Souza CH de M, Mann FA. 2011. Basic wound healing and wound closure. *In:* Mann FA, Constantinescu GM, Hun-Young Y, editors. Fundamentals of small animal surgery. Chichester (UK): Wiley-Blackwell. p. 176–86.

Valentine BA, McGavin MD. 2012. Skeletal muscle. *In:* McGavin DM, Zachary JF, editors. Pathological basis of veterinary disease. 5th ed. St. Louis (MO): Mosby Elsevier. p. 871–919.

White RAS. 1999. Skin grafting. *In:* Fowler D, Williams JM, editors. Manual of canine and feline wound management and reconstruction. Shurdington (UK): British Small Animal Veterinary Association. p. 82–94.