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*BvRx, 2014.
Letter to the Editor  Courrier des lecteurs

Front-line action to protect amphibian biodiversity

Dear Editor,

In terms of its effect on biodiversity, chytridiomycosis may be the worst disease in recorded history. It has been responsible for mass declines of frogs around the world and has been linked to the extinction or decline of over 200 species. A new threat, salamander chytridiomycosis, is on the horizon. The recently discovered fungus, *Batrachochytrium salamandrivorans* (Bsal), was translocated from Asia to Europe with devastating effects on local salamander populations. North America is a hotspot for salamander biodiversity and introduction of the fungus would have catastrophic consequences on native populations. Efforts are underway to prevent its entry into Canada and to ensure it can be found early, if introduced.

Veterinarians working with pet stores and amphibian owners are encouraged to be vigilant for this disease because of concerns regarding the possible importation, movement, and release of this pathogen into Canada via the pet trade. *Batrachochytrium salamandrivorans* infects only the skin, never going into deeper tissues. In the skin it can cause reddening and ulceration, often followed by secondary bacterial infection. Skin lesions are not always obvious, especially in Asian salamanders that act as carriers. Even in susceptible salamanders, clinical signs sometimes consist only of severe lethargy, weight loss, followed by a quick death. To diagnose salamander chytridiomycosis it is necessary to confirm the concurrent presence of skin lesions and Bsal fungus. Microscopic examination of skin, fixed in either formalin (10%) or ethanol (70%), confirms the lesions while a PCR test on skin swabs or tissue confirms the presence of Bsal. Fact sheets and links to further information on this disease can be found on the Canadian Wildlife Health Cooperative (CWHC) website (http://www.cwhc-rcsf.ca/bsal.php). Besides investigating mortality events in wild salamanders, the CWHC can assist in diagnosing the disease in captive individuals.

Veterinary clinicians are ideally placed to inform pet owners about salamander chytridiomycosis, including its clinical signs and the importance of never releasing captive amphibians into the wild. Another key preventive step is treating water and waste from amphibian cages properly: wastewater should be disinfected with bleach (1/4 to 1/2 cup per liter of water) for at least 10 minutes before disposal. Veterinarians and pet owners should discuss salamander chytridiomycosis with pet shop staff to promote sourcing animals only from suppliers known to screen for the disease or have adequate biosecurity in place to prevent importation of infected animals.

Salamander chytridiomycosis is not yet a reportable disease, but because of the devastating effects that its introduction into North America would entail, suspicious deaths of salamanders both in the wild and in captivity should be investigated. Veterinarians are at the front line of prevention by helping monitor possible introductions via the pet trade and by helping pet stores and pet owners understand their responsibilities in terms of preventing release of potentially infected animals and their waste products.

Craig Stephen, DVM, PhD
Canadian Wildlife Health Cooperative

Constructive and professional comments made in the spirit of intellectual debate are welcomed by the Editor. Writers are expected to be respectful of others and to ensure that letters are considerate and courteous. The Editor reserves the right to remove comments deemed to be inflammatory or disrespectful.
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The more we are able to peer into the future, the better equipped we will be to prepare ourselves to do well in the environment ahead. It may therefore be interesting to look at trends we can expect in veterinary medicine in the upcoming years.

The dominant theme seems to be that opportunities for veterinarians to do more for the health of pets will increase but the new procedures will often cost more (1,2). Advances that have been suggested include wide availability of minimally invasive treatments; improved cancer treatments such as immunotherapy; more effective diagnostic tools; increasing acceptance of alternative therapies; greater emphasis on preventive programs including genetic testing and screening; remote sensing to monitor animals; more application of stem cells in regenerative medicine; and more behavioral wellness techniques for pets. Veterinarians will manage animal health with more selective use of antimicrobials. These predictions are likely to come about as several are already being offered as a part of progressive practices.

Furthermore, as knowledge increases and a wider range of techniques and approaches become available, the standard of care will continue its upward trend, with increasing costs. There is already a lively debate about adjusting care to client’s financial means and concomitant concern about risking one’s license for not providing the “gold standard.”

What about large animal practice? Changes in food animal operations are likely to require changes in the way veterinary services are delivered. In the United States, the Department of Agriculture Veterinary Services Grant Program is operating to address this issue for rural veterinary practice. In Canada, a trend towards fewer but larger farms has been identified in both dairy (3) and cow-calf (4) operations. Veterinarians are likely to be less involved in the delivery of technical services and more involved in the supervision of animal health at the herd level for beef cattle (5). Individual animal medicine and surgery skills will continue to be important for dairy practitioners (6). In equine...
practice a trend towards delivering services at the track rather than at a distant hospital will likely accelerate.

For small animals, pet insurance is proposed as a mechanism to help pet owners meet the increasing costs of the advanced care that will be available for their pets. Traditional pet insurance is certainly one mechanism to spread the risk and thereby reduce the costs for individuals and should continue to be encouraged by both the veterinary profession and the insurance industry. Wellness programs can also be helpful in mitigating costs. Another way in which costs for individuals may be reduced would be alternative ways of delivering veterinary services. Would costs be reduced if we developed central facilities with state-of-the-art equipment and diagnostic tests, with this facility providing services for a large number of clinics in a town or city? This type of arrangement is most effective where there is shared ownership of the facility and shared commitment to using the service.

For large animals, the needs can probably be met by continuing to track the trends, ensuring there are veterinary technicians trained to play a larger role in assisting veterinarians, and modifying the education of veterinarians to meet changing demands. For us to optimally serve our clients in both companion animal and large animal practice our professional organizations and veterinary schools need to continue to provide education and leadership with an eye to the future.

References

Ethical question of the month — August 2016

A good friend and strong animal advocate who works at the local animal shelter contacts you for your professional opinion. A middle-aged cross-bred dog that has been at the shelter for several weeks has been treated symptomatically on two occasions by the shelter veterinarian for anorexia and dehydration. On both occasions the dog improved following treatment with analgesics, vitamins, and intravenous fluids. The dog is considered very “adoptable” but interested parties have been warned that the dog may need “extra care.” Recently an interested couple was told that the dog may need some extra veterinary attention but that if they did not adopt the dog, it likely would be euthanized. The couple agreed to the adoption but two days later the dog was found dead in the kennel. A postmortem examination revealed lymphoma. Your friend would like your professional opinion on the handling of this case. You appreciate all the good work that these shelters do and you know that the shelter veterinarian discounts her services to help support the shelter. How should you respond?

Question de déontologie du mois — Août 2016

Un bon ami et ardent défenseur des animaux qui travaille au refuge d’animaux local vous contacte pour obtenir votre opinion professionnelle. Un chien de race croisée et d’âge moyen qui est au refuge depuis plusieurs semaines a été traité à deux reprises par la vétérinaire du refuge pour cause d’anorexie et de déshydratation. Au cours des deux occasions, le chien s’est amélioré après le traitement analgésique, des vitamines et des solutions intraveineuses. Le chien est considéré comme très «adoptable», mais les parties intéressées ont été informées que le chien pourrait nécessiter des «soins supplémentaires». On a récemment dit à un couple intéressé que le chien pourrait avoir besoin de soins vétérinaires supplémentaires, mais que s’ils ne l’adoptaient pas, il serait probablement euthanasié. Le couple a accepté l’adoption, mais deux jours plus tard, le chien a été trouvé mort dans le chenil. Un lymphome a ensuite été découvert à l’autopsie. Votre ami aimerait connaître votre opinion professionnelle relativement à la gestion de ce cas. Vous appréciez l’excellent travail réalisé dans ces refuges et vous savez que la vétérinaire offre ses services à rabais pour appuyer le refuge. Comment devriez-vous répondre?

Responses to the case presented are welcome. Please limit your reply to approximately 50 words and forward along with your name and address to: Ethical Choices, c/o Dr. Tim Blackwell, 6486 E. Garafraxa, Townline, Belwood, Ontario N0B 1J0; telephone: (519) 846-3413; fax: (519) 846-8178; e-mail: tim.e.blackwell@gmail.com
Suggested ethical questions of the month are also welcome! All ethical questions or scenarios in the ethics column are based on actual events, which are changed, including names, locations, species, etc., to protect the confidentiality of the parties involved.

Les réponses au cas présenté sont les bienvenues. Veuillez limiter votre réponse à environ 50 mots et nous la faire parvenir par la poste avec vos nom et adresse à l’adresse suivante : Choix déontologiques, a/s du D’ Tim Blackwell, 6486, E. Garafraxa, Townline, Belwood (Ontario) N0B 1J0; téléphone : (519) 846-3413; télécopieur : (519) 846-8178; courriel : tim.e.blackwell@gmail.com
Les propositions de questions déontologiques sont toujours bienvenues! Toutes les questions et situations présentées dans cette chronique s’inspirent d’événements réels dont nous modifions certains éléments, comme les noms, les endroits ou les espèces, pour protéger l’anonymat des personnes en cause.

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Ethical question of the month — May 2016

A veterinarian treats a middle-aged dog with a mild cough symptomatically and fails to identify a heart murmur. Another veterinarian treats a vomiting dog symptomatically and fails to test for an intestinal blockage. A third veterinarian treats a calf that is not eating with antibiotics and fails to consider rabies in the differential diagnosis. In each of these cases a second opinion is sought after the initial treatment fails to resolve the clinical signs. In each case the second opinion veterinarian, with the benefit of knowing the failed treatment histories, performs further diagnostics and arrives at the correct diagnosis. In these and similar situations the initial veterinarians are at risk of being cited for a substandard level of care. Are veterinarians allowed to make mistakes? Does every case require that all possible diagnoses be explored at the time of the first examination?

Question de déontologie du mois — Mai 2016

Un vétérinaire traite un chien d’âge mûr souffrant d’une légère toux symptomatique et il n’identifie pas un souffle cardiaque. Un autre vétérinaire traite les symptômes d’un chien qui vomit et n’effectue pas de tests pour détecter un blocage intestinal. Un troisième vétérinaire traite un veau qui ne mange pas à l’aide d’antibiotiques et n’envisage pas la rage dans le diagnostic différentiel. Dans chacun des cas, une deuxième opinion est sollicitée après que l’échec du traitement initial. Dans chacun des cas, le vétérinaire de la deuxième opinion, qui a l’avantage de connaître l’anamnèse des traitements infructueux, effectue d’autres tests diagnostiques et obtient le bon diagnostic. Dans ces situations et dans d’autres exemples semblables, les premiers vétérinaires s’exposent au risque d’être accusés d’avoir fourni des soins inférieurs aux normes. Doit-on, dans tous les cas, explorer tous les diagnostics possibles au moment du premier examen?

Pursuing all diagnostic possibilities — A comment

Yes, I believe veterinarians can make mistakes like everyone else in society. As long as the veterinarian took a reasonable medical approach to a diagnosis, mistakes are always possible. These would include an appropriate VCPR, a detailed history of the case, a short list of the most likely diagnoses and the options for further diagnostic options plus the potential success of the current therapy chosen. A client should be offered the choice of having all possible diagnoses explored, but they may chose not to follow that course of action. As for the risk of being cited for an insubstantial level of care, I might suggest the answer would be “it depends” and that would hold true for all of the cited examples.

An ethicist’s commentary on pursuing all diagnostic possibilities

One of my human physician friends tells the story of being a medical student working in the emergency room of a large city hospital. It was standard practice for the hospital in those days to have a prominent specialist oversee the emergency room on weekends. On the weekend in question, a very well-known car-

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The point is that in the situations cited in this case, the

veterinarians diagnosed and treated based on probability and

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and calves go off feed for a multiplicity of reasons. Certainly,

in the case of the calf, if rabies is common in the area, it would

be reasonable to exclude it at the outset. But failing such an

unusual condition, veterinarians do the reasonable thing based

on common conditions resulting in the symptoms. Imagine a

client’s response if a veterinarian would prescribe a full cardiac

workup for a dog with a cough, or rabies testing for a calf who

has just gone off feed!

It is a cliché in both human and veterinary medicine that

when one hears hoofbeats, one should think horses, not zebras.

Specialists, on the contrary, are programmed to seek out zebras.

Additionally, the general practitioner very often knows facts

about the patient or client that are relevant to normal diagnosis

and treatment, for example how likely the client is to adhere
to a therapeutic regimen. When a human or animal patient

is brought in suffering from chills, fever, vomiting, diarrhea,
anorexia and similar common symptoms, the general practitio-
nner is not obliged to think Ebola or Marburg virus, even though

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workup for a dog with a cough, or rabies testing for a calf who

has just gone off feed!
General practitioners are responsible for diagnosing probabilities rather than excluding all possibilities, however remote. In all the cases cited in our example, the general practitioner should not be blamed for not finding the correct diagnosis on the first go around. In response to the specific question the case poses, veterinarians being human, and not omniscient, are allowed to make mistakes.

I once heard a dean of a veterinary school tell a student not to be afraid to prescribe a wide variety of diagnostic tests. “After all,” he continued, “you need to pay for the diagnostic machinery.” That is an unacceptable way to practice medicine, and if followed, can place veterinary medicine in jeopardy with society. Only when your initial plausible diagnosis fails, is it reasonable to move forward with excluding less likely possibilities.

Bernard E. Rollin, PhD
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CHARLOTTETOWN • PEI

CVMA CONVENTION welcomes everyone "from away"
1. A 5-month-old Boston terrier presents with a continuous left basilar murmur and bounding femoral arterial pulses. Which of the following is the most likely cause of the murmur?
   A. Ventricular septal defect
   B. Subaortic stenosis
   C. Patent ductus arteriosus (PDA)
   D. Pulmonic stenosis
   E. Mitral valve dysplasia

2. A 3-year-old male dachshund is presented for hair loss. Examination reveals complete hair loss affecting the entire ventrum. The skin in this area is completely normal in appearance and the dog is not pruritic. What is the most appropriate diagnostic test to confirm the presumed diagnosis?
   A. Skin scrapings
   B. Serum allergy testing
   C. Intradermal allergy testing
   D. Skin biopsy
   E. Elimination diet trial

3. A 16-year-old domestic short-hair cat has weight loss, polyphagia, polyuria, polydipsia, diarrhea, and tachycardia. A thyroid profile reveals that all thyroid hormone concentrations are within the middle of the normal reference ranges. Which of the following is the best interpretation of these results?
   A. Hyperthyroidism has been ruled out.
   B. Hyperthyroidism has been confirmed with the information available.
   C. Hyperthyroidism has not been ruled out; this cat may have occult hyperthyroidism.
   D. This cat has hypothyroidism.
   E. This cat should be started on methimazole.

1. Un Boston terrier âgé de 5 mois présente un souffle basilaire gauche continu et des pouls artériels fémoraux bondissants. Parmi les causes suivantes, laquelle est la plus probable pour ce souffle?
   A. communication interventriculaire;
   B. sténose subaortique;
   C. persistance du canal artériel;
   D. sténose pulmonaire;
   E. dysplasie mitrale.

2. Un Teckel mâle âgé de 3 ans présente une perte de poils. L’examen révèle une perte complète de poils qui affecte le ventre en entier. L’apparence de la peau de cette région est complètement normale et il n’y a pas de prurit. Laquelle des épreuves de diagnostic suivantes est la plus appropriée pour confirmer le diagnostic de présomption?
   A. raclages cutanés;
   B. test d’allergie sérique;
   C. test d’allergie intradermique;
   D. biopsie cutanée;
   E. essai diététique éliminatoire.

3. Un chat domestique à poil court âgé de 16 ans souffre de perte de poids, de polyphagie, de polyurie, de polydipsie, de diarrhée et de tachycardie. Un profil thyroïdien révèle que toutes les concentrations thyroïdiennes sont au milieu des limites normales de référence. Parmi les interprétations suivantes des résultats, laquelle est la meilleure?
   A. L’hyperthyroïdisme a été éliminé.
   B. L’hyperthyroïdisme a été confirmé avec les informations disponibles.
   C. L’hyperthyroïdisme n’a pas été éliminé; ce chat peut souffrir d’hyperthyroïdisme occulte.
   D. Ce chat souffre d’hypothyroïdisme.
   E. On doit débuter un traitement au méthimazole.
4. Which of the following is the most likely diagnosis for a 3-year-old mare with lethargy, poor exercise tolerance, increased sensitivity to cold temperatures, and delayed shedding of hair?
   A. Hypothyroidism
   B. Equine metabolic syndrome
   C. Thyroid adenocarcinoma
   D. Adrenal exhaustion syndrome

5. A dairy cow is re-presented 24 hours after a standing laparotomy for correction of a left displaced abomasum. The complaint is extensive incisional and sublumbar subcutaneous emphysema. There are no other problems found. Which of the following is the likely diagnosis?
   A. Bovine respiratory syncytial viral infection
   B. Abomasal perforation
   C. Peritonitis
   D. Clostridial myositis
   E. Escape of entrapped operative intraperitoneal free air

(See p. 893 for answers./Voir les réponses à la page 893.)
Dr. Troy Bourque of Okotoks, Alberta, has been appointed the 68th national president of the Canadian Veterinary Medical Association (CVMA). Dr. Bourque succeeds Dr. Nicole Gallant, of Kensington, Prince Edward Island, whose term as president officially came to an end on July 10, 2016.

Dr. Bourque is originally from Fredericton, New Brunswick, and graduated from the Atlantic Veterinary College, University of Prince Edward Island, in 2000. Dr. Bourque was a mixed animal veterinarian for 14 years in Okotoks where he focused on cow-calf, equine, and small animal practice. In 2014 he began working as an emergency veterinarian at Fish Creek 24-Hour Pet Hospital in Calgary and now also works at Big Rock Animal Clinic, practicing small animal medicine, in Okotoks.

Dr. Bourque was involved in the Alberta Veterinary Medical Association (ABVMA) for 14 years and served on Council from 2006 to 2012. He was president of the ABVMA in 2010. Dr. Bourque has been involved with the CVMA for over 5 years on various committees including the Executive Committee, the Communications Advisory Group, and most recently the chair of the Veterinary Pharmaceutical Stewardship Advisory Group. He is looking forward to his year as president of the CVMA.

“I hope to make a positive contribution to the veterinary profession,” says Dr. Bourque. “I look forward to continuing my contributions to the Canadian Veterinary Medical Association and I am delighted to take on my new role as president.”

Dr. Bourque’s wife, Alix, is a registered nurse in High River, Alberta. The Bourque family consists of Troy and Alix’s son Sam, their golden retriever, Roper, 2 horses, and 2 cats. Dr. Bourque enjoys spending time with his family; they love to hike, fish, camp, and enjoy being outdoors. Dr. Bourque’s other passion is photography; in his spare time you can find him behind his camera.

Le Dr Troy Bourque, d’Okotoks, en Alberta, a été nommé 68e président national de l’Association canadienne des médecins vétérinaires (ACMV). Le Dr Bourque succède à la Dr Nicole Gallant, de Kensington, à l’île-du-Prince-Édouard, dont le mandat de présidente a officiellement pris fin le 10 juillet 2016.

Le Dr Bourque est originaire de Fredericton, au Nouveau-Brunswick, et il a obtenu son diplôme à l’Atlantic Veterinary College de l’Université de l’île-du-Prince-Édouard, en 2000. Le Dr Bourque a exercé en pratique mixte pendant 14 ans à Okotoks où il s’est concentré sur la pratique des veaux de naissance, les équidés et les petits animaux. En 2014, il a commencé à travailler en tant que vétérinaire d’urgence à clinique Fish Creek 24-Hour Pet Hospital à Calgary et il travaille maintenant aussi à la Big Rock Animal Clinic, où il pratique la médecine des petits animaux, à Okotoks.

Le Dr Bourque œuvre au sein de l’Alberta Veterinary Medical Association (ABVMA) depuis 14 ans et il a siégé au Conseil de 2006 à 2012. Il a été président de l’ABVMA en 2010. Le Dr Bourque participe aux activités de l’ACMV depuis plus de cinq ans en siégeant au sein de divers comités, dont le comité exécutif, le Groupe consultatif des communications et, plus récemment, à titre de président du Groupe consultatif sur l’antibiogouvernance des produits pharmaceutiques vétérinaires. Il se réjouit à la perspective de son année à la présidence de l’ACMV.

« J’espère contribuer positivement à la profession vétérinaire », dit le Dr Bourque. « J’ai hâte de poursuivre ma contribution à l’Association canadienne des médecins vétérinaires et je suis ravi d’assumer mes nouvelles fonctions de président. »

La femme du Dr Bourque, Alix, est infirmière autorisée à High River, en Alberta. La famille Bourque se compose du fils de Troy et Alix, Sam, de leur Golden retriever, Roper, de deux chevaux et de deux chats. Le Dr Bourque aime passer du temps avec sa famille pour faire de la randonnée, du camping et des activités de plein air et aller à la pêche. L’autre passion du Dr Bourque est la photographie et, dans ses temps libres, vous pouvez le trouver derrière la lentille de sa caméra.
Animal Health + Human Health + Planet Health = One Health

Animal Health Week 2016

The Canadian Veterinary Medical Association (CVMA) is reminding animal owners that safeguarding the health of their animals not only protects their animals, but ensures the health of humans and the environment as well. Every step you take to protect the animals in your care contributes to the global health of the population and the planet.

Under the campaign slogan, “Animal Health + Human Health + Planet Health = One Health,” Animal Health Week, a national public awareness campaign running from October 2 to 8, 2016, highlights the importance of working together to protect the health of animals, people and the planet wholly and globally.

Dr. Nicole Gallant, 2015-16 CVMA president, explains why her clinic is celebrating this year’s Animal Health Week.

“It is becoming more and more apparent that veterinarians, doctors and scientists need to work together to ensure the healthy future of animals, humans, and the planet,” says Dr. Gallant. “We’re celebrating Animal Health Week at our clinic because we realize the importance of educating our clients about the One Health initiative. The care we provide our animals has an impact on the health of the human population and the environment we live in. It is important that we share this information with our clientele.”

We invite you to share your celebrations on Facebook or tweet using the hashtag #celebrateAHW.

Our generous supporters

Generous support of the 2016 Animal Health Week campaign is provided by Principal Sponsor Petsecure Pet Health Insurance, and Program sponsors iFinance Canada (Petcard) and Merial. This month, we invite you to learn more about Program Sponsor, iFinance Canada (Petcard).

Petcard-iFinance Pet has been proudly offering Canadian pet owners flexible payment options for both planned and emergency veterinary procedures for over 20 years. By working with hundreds of thousands of our furry loved ones access the best in medical care by removing financial barriers to treatment. Petcard helps Canadians, from all walks of life, and their pets by relieving the undue financial and physical stresses that an unexpected illness can cause when one of our most vulnerable family members falls ill. It offers an opportunity for pet owners to make choices concerning their pets’ health that are not based solely on their current financial situation.

Santé animale + Santé humaine + Santé de la planète = Une santé

Semaine de la vie animale 2016

L’Association canadienne des médecins vétérinaires (ACMV) rappelle aux propriétaires d’animaux que la protection de la santé de leurs animaux préserve non seulement les animaux, mais qu'elle assure aussi la santé des humains et de l'environnement. Toutes les mesures que vous prenez pour protéger les animaux confiés à vos soins contribuent à la santé mondiale de la population et de la planète.

Sous le slogan de la campagne, « Santé animale + Santé humaine + Santé de la planète = Une santé », la Semaine de la vie animale, une campagne nationale de sensibilisation du public, se déroulera du 2 au 8 octobre 2016 afin de souligner l’importance du travail collectif pour protéger intégralement la santé des animaux, des personnes et de la planète, et ce, à l’échelle mondiale.

La Dʳ Nicole Gallant, présidente 2015–2016 de l’ACMV, explique pourquoi sa clinique célébtre la Semaine de la vie animale de cette année.

« Il devient de plus en plus évident que les vétérinaires, les médecins et les scientifiques doivent travailler ensemble afin d’assurer un avenir en santé pour les animaux, les humains et la planète », dit la Dʳ Gallant. « Nous célébrons la Semaine de la vie animale à notre clinique parce que nous réalisons qu’il est important d’informer nos clients à propos de l’initiative Une santé. Les soins que nous prodiguons aux animaux ont un impact sur la santé de la population humaine et de l’environnement dans lequel nous vivons. Il est important de communiquer ces renseignements à notre clientèle. »

Nous vous invitons à partager vos célébrations sur Facebook ou Twitter en utilisant le hashtag #célébronslaSVA.

Nos généreux commanditaires

Un généreux soutien de la campagne de la Semaine de la vie animale 2016 est offert par notre commanditaire principal Petsecure assurance maladie pour animaux et par les commanditaires de programmes iFinance Canada (Petcard) et Merial. Ce mois-ci, nous vous invitons à en apprendre davantage à propos de notre commanditaire de programme, iFinance Canada (Petcard).

Depuis plus de 20 ans, Petcard-iFinance Pet est fier d’offrir des options de paiement flexibles aux propriétaires d’animaux de compagnie canadiens, tant pour les interventions vétérinaires prévues que les soins d’urgence. En travaillant avec des milliers de pratiques vétérinaires à l’échelle du Canada, Petcard a aidé des centaines de milliers de nos amis à fournir à avoir accès aux meilleurs soins médicaux en éliminant les obstacles financiers au traitement. Petcard aide les Canadiens, qui proviennent de tous les milieux, et leurs animaux de compagnie en atténuant les stress financiers et physiques inutiles qu’une maladie imprévue peut causer lorsque le membre le plus vulnérable de notre famille est malade. Petcard offre l’occasion aux propriétaires d’animaux de faire des choix concernant la santé de leurs animaux de compagnie qui ne sont pas uniquement basés sur leur situation financière actuelle.

Les membres de l’ACMV peuvent offrir Petcard à leur clinique ou à leur pratique en appelant au 1-888-689-9876, en envoyant un
CVMA members can offer Petcard at their clinics or offices by calling 1-888-689-9876, e-mailing (info@petcard.ca), or visiting the website (www.petcard.ca) for more information.

Animal Health Week was created to promote animal health and responsible animal ownership, celebrate the human-animal bond and raise public awareness of the services provided by veterinary professionals. Veterinarians, veterinary health care teams, pet owners and animal enthusiasts across Canada have been celebrating and benefitting from the national public awareness campaign since 1985.

During this week-long campaign in the fall, many veterinary clinics host open houses, plan dog washes, organize pet poetry or photo contests, and clinic tours. Some veterinarians will visit school children or appear on television to talk about animal health care.

courriel (info@petcard.ca) ou en visitant le site Web (www.petcard.ca) pour obtenir de plus amples renseignements.

La Semaine de la vie animale a été créée afin de promouvoir la santé animale ainsi qu’une possession responsable des animaux de compagnie, de célébrer le lien humain-animal et de rehausser la sensibilisation du public à l’égard des services offerts par les professionnels vétérinaires. Les vétérinaires, les équipes des soins vétérinaires, les propriétaires d’animaux et les amateurs d’animaux partout au Canada célèbrent cette campagne nationale de sensibilisation du public depuis 1985.

Durant cette campagne d’une semaine à l’automne, beaucoup de cliniques vétérinaires organisent des journées portes ouvertes, tiennent des lave-chiens, organisent des concours de poésie ou de photographies des animaux de compagnie et donnent des visites de la clinique. Par ailleurs, certains vétérinaires visiteront les écoles ou iront à la télévision pour parler de la santé animale.

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**CVMA Insurance Program**

The CVMA Insurance Program is a group insurance solution designed exclusively for veterinarians and overseen by the CVMA for the protection of its members. Some of the unique benefits of this program are not available elsewhere and are available only to members.

All CVMA members can benefit from this program: practice owners, associates, alternative career path veterinarians, recent veterinary graduates or veterinary students. As a CVMA member, part of a large purchasing group, you benefit from the CVMA’s strong negotiating power and its ability to provide you with preferred group rates and the most comprehensive and competitive insurance and risk management solutions.

The unique structure of this program, compared to the traditional open market structure, provides the “right” level of coverage and protection to meet your needs. It also provides stabilization of insurance costs by spreading claims over the entire pool; flexibility with different coverage options to choose from; immediate premium savings upon joining the program; and even the potential for future returns of premium to insured members in low-claiming years.

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**Programme d’assurance de l’ACMV**

Le Programme d’assurance de l’ACMV est une solution d’assurance de groupe conçue exclusivement pour les vétérinaires et supervisée par l’ACMV afin de protéger ses membres. Certains des avantages uniques de ce programme ne sont pas offerts ailleurs et ils sont exclusifs aux membres.

Tous les membres de l’ACMV peuvent profiter de ce programme : les propriétaires de pratique, les vétérinaires salariés, les vétérinaires dans des carrières parallèles, les diplômés vétérinaires récents ou les étudiants en médecine vétérinaire. En tant que membre de l’ACMV et de participant à un important groupe d’achat, vous profitez du puissant pouvoir de négociation de l’ACMV et de sa capacité de vous offrir des tarifs de groupe préférentiels ainsi que des solutions d’assurance et de gestion des risques les plus complètes et les plus concurrentielles.

La structure unique de ce programme, comparativement à la structure traditionnelle sur le marché ouvert, offre le niveau “adéquat” de protection afin de répondre à vos besoins. Elle procure aussi une stabilisation des coûts d’assurance en étalant les réclamations sur l’ensemble du groupe et elle offre une flexibilité avec différentes options de couverture ainsi que des économies immédiates sur les primes dès l’adhésion au programme et même le potentiel de remboursements futurs pour les membres assurés lors des années de faibles réclamations.

L’ACMV offre quatre catégories d’assurance à ses membres :

1. **Programme Affinité** (pour les personnes à l’extérieur d’un régime de groupe)
   - Assurance vie
   - Décès et mutilation par accident
   - Invalidité de longue durée

2. **Assurance commerciale autoprotégée** (offre une protection financière pour votre pratique et votre entreprise. Quarante-trois pour cent des primes sont investies dans un fonds appartenant aux membres pour payer les réclamations)
   - Faute professionnelle
   - Responsabilité publique
The CVMA offers 4 classes of insurance to its members:
1. **Affinity Program** (for individuals outside of an employee group plan)
   - Life insurance
   - Accidental death and dismemberment
   - Long-term disability
2. **Commercial Protected Self-Insurance** (provides financial protection for your practice/business. Forty-three percent of premiums is held in a member-owned fund to pay claims)
   - Malpractice
   - Public liability
   - Building and equipment
   - Business operations
3. **Employee Group Benefits** (protects the health and welfare of employees/owners)
   - Extended health and dental care
   - Life insurance
   - Accidental death and dismemberment
   - Disability
4. **Personal lines** (for individuals)
   - Home
   - Automobile.

**WHERE can you access this service?**
1. **Telephone**
   Call the CVMA Insurance Program toll-free number at 1-866-860-CVMA (2862) to speak directly with an insurance representative.
2. **Website**
   Visit the website (www.cvmainsurance.com).
   The program is administered for the CVMA by Western Financial Group Insurance Solutions (in Québec, it operates as HED Courtier en Assurance Inc.). Auto and home insurance is provided by The Personal Insurance Company. The CVMA Insurance Program is exclusive to members. To participate in the program and ensure uninterrupted coverage, you must be a member and maintain membership in good standing throughout the policy period.

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**CVMA Green Veterinary Practice: New Building Construction and Renovation**

When making changes to pre-existing practice buildings or constructing new buildings, clinics should consider designing the project to meet environmental standards as outlined through Leadership in Energy and Environmental Design (LEED), Energy Star or Canada Green Building Council.

**LEED** is a 3rd-party certification program that utilizes a whole-building approach to environmental sustainability and provides building owners with the tools necessary to have an immediate and measurable impact of the efficiency of their building. There are opportunities for the implementation for new or existing buildings. For more information, please visit the

- Édifice et équipement
- Opérations commerciales

3. **Régime collectif d'avantages sociaux pour les employés**
   (protège la santé et le bien-être des employés et des propriétaires)
   - Régime d’assurance maladie et dentaire
   - Assurance vie
   - Décès et mutilation par accident
   - Invalidité

4. **Assurance personnelle** (pour les particuliers)
   - Habitation
   - Automobile.

**Où pouvez-vous accéder à ce service?**
1. **Par téléphone**
   Appelez à la ligne sans frais du Programme d’assurance de l’ACMV au 1-866-860-2862 pour parler directement à un représentant d’assurance.
2. **Site Web**
   Visitez le site Web (www.cvmainsurance.com).
   Le programme est administré pour l’ACMV par Western Financial Group Insurance Solutions (au Québec, il est exploité sous le nom de HED Courtier en Assurance Inc.). L’assurance automobile et habitation est fournie par La Personnelle. Le Programme d’assurance de l’ACMV est offert exclusivement aux membres. Pour participer à ce programme et garantir la continuité de votre couverture, vous devez être membre et maintenir une adhésion en règle pendant la durée de la police.

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**Pratique vétérinaire écoresponsable de l’ACMV : Nouvelle construction et rénovation**

Les cliniques qui désirent apporter des changements à des édifices existants ou qui construisent de nouveaux édifices devraient envisager de concevoir un projet qui satisfait aux normes environnementales de conception stipulées par les organismes suivants : Leadership in Energy and Environmental Design (LEED), Energy Star ou le Conseil du bâtiment durable du Canada.

**LEED** : Un programme de certification de tiers qui utilise une approche holistique pour la durabilité du bâtiment et offre aux propriétaires de bâtiments les outils nécessaires pour avoir une influence immédiate et mesurable sur le rendement de leurs bâtiments. Il y a des possibilités de mise en œuvre dans les
bâtiments nouveaux ou existants. Pour en savoir davantage sur LEED, veuillez visiter : www.cagbc.org/Content/NavigationMenu/Programs/LEED/GoingGreenwithLEED/default.htm


Vous recherchez de l’aide pour trouver des gains d’efficacité et des améliorations afin que vous puissiez obtenir des économies importantes au niveau de votre consommation énergétique, de la consommation d’eau et des émissions des gaz à effet de serre? Le Consul忘了 le bâtiment durable du Canada a pour mission de diriger et d’accélérer la transformation afin de construire des bâtiments, des édifices et des maisons à haut rendement énergétique et des collectivités durables et saines à l’échelle du Canada. Pour en savoir davantage, visitez son site Web : http://www.cagbc.org/cbdca/


VetLaw™ Online Legal Advice Column

VetLaw Online™ est un service juridique en ligne exclusif destiné aux membres de l’ACMV à travers le site Web de l’ACMV, M. Douglas (Doug) C. Jack, LL.B., un avocat se spécialisant en questions juridiques vétérinaires, vous offre des conseils d’une nature générale sur une vaste gamme de sujets juridiques vétérinaires.

Tous les membres de l’ACMV peuvent profiter de ce service, que vous soyez un propriétaire de pratique «aguerri», un vétérinaire salarié ou un médecin vétérinaire qui a terminé son cours récemment. Si vous avez une question juridique vétérinaire, vous profitez de l’expérience et de la réponse rapide et fiable de M. Jack. Si vous n’avez pas de questions spécifiques, mais que vous désirez connaître les sujets abordés dans cette rubrique, vous pouvez consulter les questions déjà posées, qui sont affichées en ligne.

Le droit vétérinaire en ligne fournit des conseils d’une nature générale sur un vaste éventail de sujets, notamment :

- L’achat et la vente d’une clinique vétérinaire
- L’interprétation des contrats d’emploi
- La cessation des relations d’emploi
VetLaw Online™ provides advice of a general nature on a wide variety of subjects including:
• Purchase/sale of a veterinary hospital
• Interpretation of employment agreements
• Termination of employment relationships
• Professional compliance
• Client complaints
• Problematic accounts receivable.

It is important to remember that the advice provided through VetLaw Online™ is not intended as specific legal guidance and recommendations; consult with your own professional advisors or legal counsel if such guidance is required.

• Go to the website (www.canadianveterinarians.net);
• Log-in using your first name, last name and password (if you do not know your password, you can request it from the CVMA);
• Click on Practice and Economics and then under Vet Law Online, click on either Submit a Question or Previously Asked Questions.

The CVMA Welcomes Dr. Kathleen MacMillan to Council as AVC/FMV Representative

The Canadian Veterinary Medical Association (CVMA) is pleased to welcome Dr. Kathleen MacMillan to Council as AVC/FMV (Atlantic Veterinary College/Faculté de médecine vétérinaire) representative. Dr. MacMillan replaces Dr. Barb Horney whom we thank for her service. Dr. MacMillan’s term is effective immediately and will end December 31, 2017.

Dr. MacMillan is a 2001 graduate of the AVC at the University of Prince Edward Island. She grew up on a horse farm in Prince Edward Island and knew from the young age of 6 that she wanted to be an equine veterinarian. Dr. MacMillan worked as an associate veterinarian in equine practice prior to establishing a solo equine ambulatory practice in Prince Edward Island. In 2010, she joined the faculty at the AVC and gets great satisfaction in taking care of her equine patients in the Ambulatory Equine Service while teaching future veterinarians the intricacies of equine practice. Dr. MacMillan strongly believes in continuing to pursue knowledge and in 2013 successfully became a Diplomate of the American Board of Veterinary Practitioners in equine practice. She has a strong interest in equine sports medicine, equine welfare and preventive medicine.

L’ACMV accueille la Dr. Kathleen MacMillan au Conseil en tant que représentante de l’AVC/FMV

L’Association canadienne des médecins vétérinaires (ACMV) est heureuse d’accueillir la Dr. Kathleen MacMillan au sein du Conseil à titre de représentante de l’AVC/FMV (Atlantic Veterinary College/Faculté de médecine vétérinaire de l’Université de Montréal). La Dr. MacMillan remplace la Dr. Barb Horney que nous remercions pour ses services. Le mandat de la Dr. MacMillan entre en vigueur immédiatement et prendra fin le 31 décembre 2017.

La Dr. MacMillan est une diplômée de la promotion 2001 de l’AVC de l’Université de l’Île-du-Prince-Édouard. Elle a grandi dans une ferme équine à l’Île-du-Prince-Édouard et elle savait dès l’âge de six ans qu’elle désirait devenir vétérinaire équine. La Dr. MacMillan a travaillé en tant que vétérinaire salarié dans une pratique équine avant de fonder sa propre pratique équine ambulatoire solo à l’Île-du-Prince-Édouard. En 2010, elle a joint les rangs du corps professoral de l’AVC et elle tire une immense satisfaction des soins qu’elle prodigue à ses patients équins du Service équin ambulatoire tout en enseignant les complexités de la pratique équine aux futurs médecins vétérinaires. La Dr. MacMillan croit fermement à la poursuite de l’acquisition de connaissances et, en 2013, elle a obtenu l’agrément de spécialiste de l’American Board of Veterinary Practitioners in equine practice. Elle s’intéresse vivement à la médecine des sports équins, au bien-être équin et à la médecine préventive.

Dr./Dr. Kathleen MacMillan
CVMA Requests Your Support for Bill C-246, the Modernizing Animal Protections Act

In May 2016, the Canadian Veterinary Medical Association (CVMA) sent a letter expressing support-in-principle for Bill C-246, the Modernizing Animal Protections Act, to each federal Member of Parliament (MP).

The CVMA is now requesting that you as a CVMA member and a veterinary professional stand alongside our Association in demonstrating support for the bill by using the template found on the CVMA website to draft a letter to your local MP.

As veterinarians, we are often the first professionals to examine an abused animal. Effective legislation is an important tool to help those who deal with abused animals, including humane societies and law enforcement agencies. There is overwhelming evidence of a direct link between animal abuse and violence towards people, especially family members — including children, spouses, and elders. Therefore, legislation that deals more effectively with cruelty to animals may help play a role in breaking the cycles of violence that occur in some communities. [Excerpt from the letter template]

As you may be aware, on June 9, 2016, the Supreme Court of Canada ruled (6 to 1) that some acts of bestiality are legal in Canada and that only acts of penetration are punishable under our current animal cruelty provisions. Bill C-246 addresses this loophole as it includes a definition of bestiality (“sexual conduct between a person and an animal”).

Since 1998, the CVMA has been involved in efforts to modernize and strengthen the Criminal Code to better protect animals. Some key areas of CVMA contribution include written input to the Justice Department’s consultation paper on Crimes Against Animals (December 1998), and oral presentations to the Standing Committee on Justice and Human Rights (support of Bill C-15B, October 2001) and the Standing Senate Committee on Legal and Constitutional Affairs (objections to S-213, December 2006).

Please use the letter template to send as an e-mail or place in the mail. The postage of letters to your MP’s Parliament Hill office is free. We encourage you to also set up a meeting with your local MP to express your support in person. Find your local MP by calling 1-800-622-6232 to find his or her contact information.

In May 2016, l’Association canadienne des médecins vétérinaires (ACMV) a envoyé une lettre exprimant son appui de principe au projet de loi C-246, la Loi sur la modernisation des mesures de protection des animaux, à chacun des députés fédéraux.

L’ACMV vous demande maintenant, à titre de membre de l’ACMV et de professionnel vétérinaire, de vous ranger aux côtés de votre association afin de manifester votre appui au projet de loi en utilisant le modèle de lettre qui se trouve sur le site Web de l’ACMV afin de rédiger une lettre à votre député local.

À titre de vétérinaires, nous sommes souvent les premiers professionnels à examiner un animal victime de violence. Une législation efficace représente un oubli important en vue d’aider ceux qui s’occupent des animaux victimes de violence, dont les sociétés de protection des animaux et les autorités responsables de l’application de la loi. Il a été prouvé qu’il existe un lien direct entre la violence envers les animaux et la violence envers les personnes, particulièrement les membres de la famille, y compris les enfants, les conjoints et les aînés. Par conséquent, une loi qui gère plus efficacement la cruauté envers les animaux peut contribuer à rompre le cycle de la violence dans certaines collectivités. [Extrait tiré du modèle de lettre]

Comme vous le savez probablement, le 9 juin 2016, la Cour suprême du Canada a jugé à 6 contre 1 que certains actes de bestialité sont légaux au Canada et que seuls les actes de pénétration sont punissables en vertu des dispositions actuelles. Signalons que le projet de loi C-246 corrige cette échappatoire car il contient une définition de la bestialité (« activité sexuelle entre une personne et un animal »).


As reported in the Manitoba’s message last year, the MVMA was anticipating the opening the Manitoba’s Veterinary Medical Act as well as assumption of the regulation of animal health technologists. Much of the past year has been focused on these 2 items.

Amendments to Manitoba’s Veterinary Medical Act

In March 2014 the MVMA was approached by the Government of Manitoba regarding veterinary fees. The government’s primary objective was to review complaints received by the Consumer Protection Department. The government felt there needed to be greater transparency and clarity in veterinary fees.

In the spring of 2015, the MVMA began consulting with the government regarding the proposed amendments to the Veterinary Medical Act. The most contentious amendment was the “fee disclosure” amendment. The MVMA worked cooperatively to strike a balance — one that let the government insert the “fee disclosure” amendment. The MVMA worked cooperatively to strike a balance — one that let the government insert this amendment but left much of the detail in the MVMA’s hands.

During the consultation process, the government also floated the idea that it should have the final say in regulating aspects of veterinary practice. The MVMA successfully convinced the government that such broad and ominous powers were unnecessary and undermined the role of the MVMA as the statutory regulator of the veterinary profession in Manitoba.

After moving through the various legislative stages, the Act had Third Reading and Royal Assent (and came in force) on November 5, 2015. Major amendments to the Act include:

1. Requirement for MVMA to enact a Fee Disclosure By-Law
   • The amendments to the Act outline fee disclosure by-law expectations, while allowing the MVMA to set the requirements in bylaws.

2. MVMA Council composition change
   • The MVMA Council will now have representation from 3 groups; licensed members, technologists, and the public for a total of 11 members on the MVMA Council. There will be 7 licensed members (including the immediate past president), 2 technologist representatives, and 2 public representatives appointed by the province.

3. Clarification of member voting rights
   • All members (all veterinarian classes; all technologist classes; life, etc.) of the MVMA will be eligible to vote
on MVMA by-laws and others matters that impact their membership category. The MVMA council will make the determination as to which member categories will be eligible to vote on the various matters before the membership.

4. Animal health technologists title change
   • Updating technologists’ titles from animal health technologist to veterinary technologist.

5. Veterinary incorporation
   • This amendment will finally allow veterinarians in Manitoba to establish professional corporations.

6. Addition of primary mandate:
   • As much as the MVMA is a single association with a dual mandate (regulation as well as advocacy and member service), protection of the public is its primary mandate as established through the Veterinary Medical Act. To reinforce this mandate, a section has been added to the Act which states:
     “The association’s primary mandate is to carry out its objectives and duties, exercise its powers and govern its members in a manner that serves and protects the public interest.”

7. Ability to establish and regulate all providers of veterinary services
   • This amendment allows the MVMA the option to regulate other providers (non-veterinarian and veterinary technologist) of veterinary services as well as the jurisdiction to restrict those providing veterinary services. Further, it allows the MVMA to define the scope and level of supervision of these providers. This would be done within the MVMA by-laws.

**2016 priorities**

As a result of the amendments to the Act as well as the membership status and regulation of technologists, the MVMA must develop new or revised existing MVMA by-laws. Key by-laws to be developed and/or amended are those relating the MVMA Council and governance, membership categories, technologists’ registration and regulation, veterinary fee disclosure and veterinary corporations.

The MVMA Council has also identified the following items as other priorities to focus on in 2016: veterinary services in remote areas; temporary remote clinics; antimicrobial stewardship; and the scope of veterinary practice.

**Technologist membership in the MVMA**

After a legal review of the Veterinary Medical Act in 2014, it was discovered that the MVMA had wrongfully delegated to MAHTA (Manitoba Animal Health Technologists Association) the responsibility for the regulation of animal health technologists about 10 years ago. The MVMA has now developed technologist membership categories and has begun to correct the inappropriate delegation of regulation by bringing this duty back into its mandate.

Recent amendments to Manitoba’s Veterinary Medical Act strengthened technologists’ voice and influence in the MVMA by clarifying and ensuring technologists’ voting rights on MVMA by-laws that affect them and by designating 2 technologist MVMA Council positions. Additionally, it strengthens the admissibles au vote sur les diverses questions devant les membres.

4. Changement de titre pour les technologues en santé animale
   • Mise à jour des titres des technologues de «technologue en santé animale» à «technologue vétérinaire».

5. Constitution en société vétérinaire
   • Cet amendement permettra finalement aux vétérinaires du Manitoba de constituer des sociétés professionnelles.

6. Ajout à la mission principale :
   • Même si la MVMA est une association unique avec une double mission (réglementation ainsi que défense des intérêts et services aux membres), la protection du public fait partie de sa mission principale conformément au texte de la Loi sur la médecine vétérinaire. Pour renforcer ce mandat, un article a été ajouté à la Loi qui stipule :
     «La mission principale de l’Association est de poursuivre ses objectifs, d’exercer ses attributions et de régir la conduite de ses membres de façon à promouvoir et à protéger l’intérêt public.»

7. Capacité d’établir et de réglementer tous les fournisseurs de services vétérinaires
   • Cet amendement permet à la MVMA de réglementer d’autres fournisseurs (non-vétérinaires et technologues vétérinaires) de services vétérinaires ainsi que de limiter ceux qui fournissent des services vétérinaires. De plus, il permet à la MVMA de définir la portée et le niveau de supervision de ces fournisseurs. Cette mesure sera déterminée dans les règlements administratifs de la MVMA.

**Priorités de 2016**

À la suite des modifications à la Loi ainsi que du statut de membre et de la réglementation des technologies, la MVMA doit élaborer de nouveaux règlements administratifs et réviser les règlements existants de la MVMA. Les principaux règlements administratifs qui seront rédigés et/ou modifiés sont ceux concernant le Conseil et la gouvernance de la MVMA, les catégories de membre, l’enregistrement et la réglementation des technologies, la divulgation des tarifs vétérinaires et les sociétés vétérinaires.

Le Conseil de la MVMA a aussi identifié les éléments suivants comme étant prioritaires en 2016 : les services vétérinaires dans les régions éloignées; les cliniques temporaires dans les régions éloignées; l’antibiogouvernance; et la portée de l’exercice de la médecine vétérinaire.

**Adhésion des technologies à la MVMA**

Après un examen juridique de la Loi sur la médecine vétérinaire en 2014, il a été découvert que, il y a environ dix ans, la MVMA avait délégué à tort la responsabilité de la réglementation des technologies en santé animale à la MAHTA (Manitoba Animal Health Technologists Association). La MVMA a maintenant créé des catégories d’adhésion et a commencé à corriger la délégation inappropriée en intégrant cette fonction de nouveau à sa mission.

Des modifications récentes de la Loi sur la médecine vétérinaire du Manitoba ont renforcé la voix et l’influence des technologies au sein de la MVMA en clarifiant et en assurant le droit de vote aux technologies sur les règlements administratifs de la MVMA qui les touchent et en désignant deux sièges au Conseil de la MVMA pour les technologies. De plus, elle renforce la profession vétérinaire au
veterinary profession in Manitoba by including these key team members in the regulation and advocacy of the profession.

(by Dr. Suzanne Davidson, President, Manitoba Veterinary Medical Association)

Obituary

Jon Alan Boyd Taylor

It was with great sadness that the family of Dr. Jon Alan “Boyd” Taylor, age 67, of Amherst Nova Scotia announced his passing on Friday, February 26, 2016 with his loving family by his side at the Cumberland Regional Health Care Center.

Born in Calgary Alberta, Boyd was the son of the late Andrew and Elva (Schumann) Taylor, and moved to Don Mills, Ontario at a young age. He enjoyed many summers with his family in Strathmore, Alberta. Boyd attended the University of Waterloo for his BSc. Hon., then graduated from the Ontario Veterinary College in 1976. He was looking forward to celebrating his 40th reunion with his classmates this summer. Upon graduation, he moved to Amherst, Nova Scotia where he began practicing veterinary medicine and later purchased the Amherst Veterinary Hospital.

Boyd lived life to the fullest, he was active in numerous sports, had many hobbies and activities that he enjoyed with his friends. He was heavily involved with the soccer association. Boyd was a coach both on and off the soccer field, sharing lessons, wisdom and good judgement.

He will be deeply missed by all the lives he touched. We will carry his memory in our hearts and always share our stories.

Boyd will be deeply missed by his loving wife of 37 years Carol (MacNeil), wonderful daughters Catherine and Lindsay (Luke Sellar), his special little buddy, grandson Theo, mother in-law Catherine MacNeil, brother in-law Bruce (Anne) MacNeil, sister in-law Marilyn (John) MacNeil-Woods, nieces Meredith, Rebecca and Alannah and nephew Brent.

Survived by sister Letitia (Toney) Taylor-Ilenchuk and many uncles, aunts and cousins in Alberta. He was predeceased by his father in-law Ronald MacNeil and his special aunt Nettie.

Nécrologie

Jon Alan Boyd Taylor

C’est avec grande tristesse que la famille du Dr Jon Alan «Boyd» Taylor, 67 ans, d’Amherst, en Nouvelle-Écosse, a annoncé son décès le vendredi 26 février 2016 avec sa famille aimante à ses côtés au Cumberland Regional Health Care Center.

Né à Calgary, en Alberta, Boyd était le fils de feu Andrew et Elva (Schumann) Taylor, et il a déménagé à Don Mills, en Ontario, à un jeune âge. Il a passé de nombreux étés agréables avec sa famille à Strathmore, en Alberta. Boyd a fréquenté l’Université de Waterloo pour obtenir son B.Sc. avec spécialisation, puis son diplôme de l’Ontario Veterinary College en 1976. Il avait hâte de célébrer le 40e anniversaire de sa promotion cet été. Après l’obtention de son diplôme, il a déménagé à Amherst, en Nouvelle-Écosse, où il a commencé à exercer la médecine vétérinaire et a ensuite fait l’acquisition de la clinique Amherst Veterinary Hospital.

Boyd aimait profiter pleinement de la vie et il participait à de nombreux sports et s’intéressait à une foule de passe-temps et d’activités en compagnie de ses amis. Il s’est aussi impliqué à fond dans l’association de soccer. Boyd était un entraîneur pratique et théorique et il partageait des leçons, de la sagesse et son bon jugement.

Il manquera énormément à toutes les personnes qu’il a touchées. Nous porterons son souvenir dans notre cœur et nous partagerons toujours nos récits.

Boyd manquera terriblement à sa femme aimante de 37 ans Carol (MacNeil), à ses filles merveilleuses Catherine et Lindsay (Luke Sellar), à son petit-fils spécial Theo, à sa belle-mère Catherine MacNeil, à son beau-frère Bruce (Anne) MacNeil, à sa belle-sœur Marilyn (John) MacNeil-Woods, à ses nièces Meredith, Rebecca et Alannah et à son neveu Brent.

Article

Epidemiology of toe tip necrosis syndrome (TTNS) of North American feedlot cattle

Murray Jelinski, Kent Fenton, Tye Perrett, Chad Paetsch

Abstract — Toe Tip Necrosis Syndrome (TTNS) is predominantly a hind limb lameness of feedlot cattle that develops early in the feeding period. Retrospective analyses of feedlot health records were conducted in order to describe the epidemiology of the disease at the level of the individual animal, lot, and feedyard. Analysis of 1904 lots (cohorts of > 100 head) of cattle, from 48 feedyards, found that TTNS occurred sporadically, but clustered by both lots and feedyards. Only 3.8% of lots had ≥ 1 case of TTNS; however, 26.4% of these lots were associated with 1 feedyard. Analysis of 702 cases of TTNS found that the disease clusters early in the feeding period; the mean (median; range) number of days on feed at death was 42.3 d (27.0 d; 4 to 302 d). The disease occurred in all months of the year and affected calves, yearlings, steers, and heifers. It was equivocal as to whether the source of the animals was associated with how quickly they died of TTNS in the feedyard.

Résumé — Épidémiologie du syndrome de la nécrose du bout des doigts (SNBD) du bétail dans les parcs d’engraissement d’Amérique du Nord. Le syndrome de la nécrose du bout des doigts (SNBD) est une boiterie des membres postérieurs du bétail des parcs d’engraissement qui se développe de 1 à 4 semaines après l’arrivée au parc d’engraissement. Des analyses rétrospectives des dossiers de santé des parcs d’engraissement ont été réalisées afin de décrire l’épidémiologie de la maladie au niveau de l’animal individuel, du lot d’animaux et du parc d’engraissement. Une analyse de 1904 lots (cohortes de > 100 têtes) de bétail, provenant de 48 parcs d’engraissement, a constaté que le SNBD se produisait sporadiquement, mais qu’il était regroupé selon les lots et les parcs d’engraissement. Seulement 3,8 % des lots avaient ≥ 1 cas de SNBD; cependant, 26,4 % de ces lots étaient associés à 1 parc d’engraissement. Une deuxième analyse des 702 cas de SNBD a confirmé que la maladie se regroupe au début de la période d’engraissement; le nombre moyen de jours (médiane; écart) d’engraissement à la mort était de 42,3 jours (27,0 jours; de 4 à 302 jours). La maladie se produisait durant tous les mois de l’année et touchait les veaux, les animaux d’un an, les bouvillons et les génisses. Il était équivoque à savoir si la source des animaux était associée à la rapidité d’une mort causée par SNBD dans le parc d’engraissement.

(Introduit par Isabelle Vallières)

Introduction

Lameness is a significant disease of feedlot cattle. A retrospective study of ~1.84 million animal health records from American feedlots found that lameness accounted for 16% of treatments, 5% of deaths, and 70% of animals sent prematurely to slaughter were lame (1). A similar retrospective study of Canadian feedlot cattle found that bovine respiratory disease and lameness accounted for 42% and 40% of all treatments, respectively (2). Respondents to a more recent US survey of feedlot nutritionists, veterinarians, and managers, estimated the mean (median) incidence of lameness in feedlots to be ~3.8% (2.0%). Interdigital necrobacillosis (footrot) was considered the most common cause of lameness, followed by injury (35%), and “toe abscesses” (10%) (3). While toe abscesses were identified as a common cause of lameness, there is a paucity of information regarding the epidemiology of this disease in beef cattle.

While toe abscesses of feedlot cattle are distinct from sole ulcers and abscesses of dairy cattle (4), one of the best descriptions of toe abscesses of feedlot cattle involved a cohort of Jersey heifers in New Zealand (5). This initial report was followed by 2 reports relating to outbreaks of toe abscesses of beef cattle in American feedlots (6,7). More recently, researchers, again from New Zealand, reported on dairy heifers that developed hoof lesions similar to what is seen in feedlot beef cattle (8). Some of the first observations regarding the epidemiology of the disease...
and potential risk factors originate from these early publications. Specifically, affected cattle develop lameness shortly after being shipped and/or handled at a processing facility. Furthermore, the disease was associated with fractious or agitated animals and if the animals were exposed to wet and/or abrasive flooring conditions.

The cause of toe abscesses in feedlot cattle is a matter of speculation; however, the “abrasion theory” is perhaps the most widely accepted explanation. This theory postulates that excessive wear of the solar horn leads to separation along the apical portion of the white line, allowing for a secondary bacterial infection. These infections may penetrate the corium and progress to P3 osteitis, P2 osteomyelitis, tendonitis, tenosynovitis, cellulitis, and in some cases sepsis leading to an embolic event that culminates in death. If this theory is correct, then events that lead to excessive wear along the apical white line should be considered risk factors for the disease.

Although the disease is common to North American feedlots, no uniform nomenclature has been adopted to describe the disease. The condition has many different monikers: toe abscess, toe ulcer, apicus necrotica, apical white line disease, toe necrosis, toe tip necrosis, “P3” necrosis, and apical pedal bone necrosis. We prefer the term toe tip necrosis syndrome (TTNS) because it describes the primary pathological finding (toe tip necrosis) and it encompasses the sequelae commonly associated with the condition (6,7).

The objective of the study was to describe the epidemiology of TTNS at the level of the individual animal, the lot, and the feedyard.

Materials and methods
The over-arching objective of the study was to describe the epidemiology of TTNS at the level of the individual animal, the lot, and the feedyard. Feedlot Health Management Services (FHMS), a large multi-person feedlot consulting practice in western Canada (Okotoks, Alberta), provided the source data.

Lot and feedyard
The first objective was to describe the occurrence of TTNS by lot and feedyard, in which a lot was defined as a cohort of cattle purchased from ≥ 1 source, but grouped for financial reporting reasons. Data were restricted to lots of ≥ 100 head, feedyards located in western Canada, and the 2012 calendar year. Due to client confidentiality concerns, the number of TTNS cases per lot was provided as prevalence data (percent).

The case definition for TTNS was finding evidence of necrosis of the apex of the toe along with pathology of the 3rd phalangeal bone (P3) at the time of postmortem examination. This diagnosis was made after making a sagittal section of the claws with an axe or saw. While concurrent disease processes may have been present, if 1 or more claws had lesions that satisfied the case definition, and the lesion was deemed to be the primary reason for euthanasia or cause of natural death, then the animal was recorded as a TTNS case.

Figure 1 is a photograph of a sectioned claw taken from a TTNS case. The P3 bone is necrotic and pathological processes involve P2 and associated soft tissues. White line separation, which is pathognomonic for TTNS, was not evident in the photograph because the hoof was sectioned either medial or lateral to the point of separation.

Individual animal
The FHMS’ animal health database was queried for confirmed fatal cases of TTNS reported between January 1, 2008 and December 31, 2012, inclusive. These individual animal data originated from feedyards in western Canada and the western United States. Individual animal health records provided the following data: arrival weight; arrival date; source of procurement (auction, grass, backgrounded, ranch); gender (heifer or steer); age class (calf or yearling); number of days on feed (DOF) at 1st treatment for TTNS; number of DOF at death; date of death; whether the animal was found dead or was euthanized; location of TTNS lesion [front or hind claw(s)]; and estimated/actual weight at death. Regarding 1st treatment for TTNS, a putative diagnosis of TTNS lameness was based upon the animal exhibiting lower limb lameness, but having no observable signs of swelling or evidence of other disease processes such as foot rot or traumatic injury.

Statistical analyses
Data were compiled in a commercial spreadsheet software program (Microsoft Excel, v. 15; Microsoft Corporation, Redmond, Washington, USA) and then exported to a statistical software program (STATA, ver 14; StataCorp LP, College Station, Texas, USA). Descriptive statistics were generated for each variable, but only statistically significant findings were reported. The Kruskal-Wallis and the median test were used to assess for differences in the number of DOF until 1st treatment and until

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**Table 1. Fatal cases of toe tip necrosis syndrome by source of cattle and age class**

<table>
<thead>
<tr>
<th>Source (N = 696)</th>
<th>Calf</th>
<th>Yearling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auction (n = 545)</td>
<td>271</td>
<td>49.7%</td>
</tr>
<tr>
<td>Backgrounded (n = 69)</td>
<td>18</td>
<td>26.1%</td>
</tr>
<tr>
<td>Grass (n = 53)</td>
<td>1</td>
<td>1.9%</td>
</tr>
<tr>
<td>Ranch (n = 29)</td>
<td>22</td>
<td>75.9%</td>
</tr>
<tr>
<td>Totals</td>
<td>n = 312</td>
<td>44.8%</td>
</tr>
</tbody>
</table>

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**Figure 1.** Photograph of a sectioned claw taken from an animal with toe tip necrosis syndrome.
death by source, age class, and gender. The Mann-Whitney U-test assessed for differences in the number of DOF between the treated and nontreated cattle. Logistic regression was used to estimate the odds of the treated and nontreated cattle having to be euthanized for lameness. Kaplan-Meier (K-M) survival analyses, using the Wilcoxon test statistic, assessed for the overall equality of the survivor curves (survival functions) over time. Specifically, K-M survival analyses compared the number of DOF until 1st treatment and DOF until death by source, age class, and gender. The level of significance for all statistical tests was set at \( P < 0.05 \) (two-tailed).

**Results**

**Lot and feedyard**

Lot prevalence data were compiled from 1904 lots of cattle, ranging in size from 100 to 5443 head, representing 616831 head of cattle from 48 feedyards. Most lots (96.2%; 1832/1904) reported no cases of TTNS; 72 lots had ≥ 1 case of TTNS. Nineteen of 48 (39.6%) feedyards reported having 1 or more lots with a TTNS case. One feedyard accounted for 26.4% (19/72) of all the affected lots and 33.3% (19/57) of lots entering this same feedyard had ≥ 1 TTNS cases.

The prevalence of TTNS cases in the 72 affected lots ranged from 0.50% to 1.22%. The feedyard with the highest prevalence in a single lot (1.22%) only reported having 4 of 110 (3.6%) lots having TTNS cases.

**Individual animal**

A query of FHMS’ database returned 702 recorded TTNS cases, 6 of which had 1 or more missing data points. There was a steady decline in the number of TTNS cases recorded in each successive year: 2008, \( n = 208 \); 2009, \( n = 212 \); 2010, \( n = 155 \); 2011, \( n = 97 \); and 2012, \( n = 30 \). There were no differences across the years (2008 to 2012) with respect to either the number of DOF at the time of 1st treatment for suspected TTNS lameness (\( P = 0.72 \)) or the number of DOF at death due to TTNS (\( P = 0.42 \)); therefore, all cases were analyzed as 1 dataset.

Table 1 is a cross tabulation of the cases by source and age class. Most (78.3%; 545/696) cases were auction market-derived cattle. Across all sources, the cases were nearly evenly split between calves (44.8%; 312/696) and yearlings (55.2%; 384/696); most of the calves (77.3%; 242/313) and yearlings (65.0%; 249/383) were steers.

The epidemic curves for DOF until 1st treatment for TTNS lameness and until death followed a similar pattern with the peak number of treatments and deaths occurring early in the feeding period (Figure 2).

Table 2 provides the breakdown of DOF to 1st treatment and to death by source, age class, and gender. The overall mean (median) number of DOF at 1st treatment was 18.9 d (12.0 d), which was unrelated to source (\( P = 0.80 \), age class (\( P = 0.98 \)), and gender (\( P = 0.59 \)). A third (29.9%; 210/702) of the animals had a history of having been treated for TTNS lameness. The timing of 1st treatments started on the day of arrival (0 DOF) and continued until 203 DOF. Thirty-seven (17.6%; 37/210) animals were given antimicrobial therapy within 5 DOF, 81.1% (30/37) of which were dead within 15 d of treatment. Furthermore, 64.9% (24/37) of these early onset animals were euthanized for lameness.

The overall mean (median) number of DOF at death was 42.3 d (27.0 d); range 4 to 302 DOF. Table 2 provides a breakdown of the number of DOF at the time of death by source, age class, and gender. Thirteen animals with TTNS were dead within 7 DOF; 8 (61.5%) of which were euthanized. Most cattle (77.9%) died within 50 DOF and overall 75.2% (528/702) of animals with TTNS were euthanized versus being found dead.

The median number of DOF at death between the treated (25 DOF) and nontreated cattle (28 DOF) was not different (\( P = 0.18 \)); however, treated cattle were twice as likely to be euthanized as were the nontreated cattle (OR = 1.8; 95% CI = 1.20 – 2.71; \( P < 0.01 \)).

Kaplan-Meier (K-M) survivor analysis was used to determine if there were differences in the overall survivor functions. That is, rather than just looking at differences in the mean or median DOF until death, the K-M test compared the probabilities of the occurrence of an event (death) over time. Figure 3 is the graphical representation of the survivor functions. All 702 animals were alive at the start of the feeding period (DOF = 0), and each descending step represents the death of ≥ 1 animal(s) in a given time interval. Kaplan-Meier univariate analysis found differences in the survivor functions with respect to the number of DOF until death by source (\( P = 0.04 \)) and the number of DOF by age class (\( P = 0.04 \)), when examined over the time period from Day 0 to 302. Cattle that were backgrounded had a greater overall survival time than did the cattle from the other 3 sources. Similarly, the calves survived for a longer period than did the yearlings. The 2 variables (source and age class) were then analyzed together by controlling (stratifying) for age class (calf versus yearling). Overall, there were differences in the survivor functions by source of cattle (\( P = 0.02 \)). While differences existed in the survivor functions between 0 to 302 DOF, there were no differences in the survivor functions by source for the period 0 to 100 DOF (\( P = 0.59 \)). This is significant because 91.2% (640/702) of the cattle died within the first 100 DOF.

Animals died or were euthanized in all months of the year; however, 67.9% (477/702) of deaths occurred from September to December.
The location of the TTNS lesion was recorded in 35 cases: 1 animal (2.9%) had a TTNS lesion on a fore foot; 2 animals (5.7%) had lesions on both a hind and a fore foot; 7 animals (20.0%) had lesions in both hind feet; and 25 animals (71.4%) had a lesion in 1 hind foot.

### Discussion

The objective of this study was not to prove or disprove the “abrasion theory;” however, many of the findings can be explained within the context of this theory.

The disease occurred sporadically, but clustered at the level of the lot and feedyard. Less than 4% of the lots had ≥ 1 cases of fatal TTNS, with the highest recorded prevalence in a single lot being 1.22%. Significantly, outbreak of TTNS occurred in a feedyard in which the disease was seldom reported; only 4 of 110 lots of cattle had 1 or more cases of fatal TTNS. This suggests that the risk factors for the disease may be associated with the incoming lots of cattle. Conversely, ~25% of all the affected lots were associated with a single feedyard, which infers that feedyard-specific risk factors may also have been present. The sporadic nature of the disease coupled with the clustering by lots and feedyards suggests that the risk factors for TTNS may be ephemeral. That is, the risk factors may not always be present in time and space.

The treatment and necropsy data confirmed previous reports that TTNS clusters early in the feeding period (5–7). Of the 210 animals that received antimicrobial therapy for a presumptive diagnosis of TTNS, 50% were ≤ 12 DOF. Furthermore, confirmed cases of TTNS occurred as early as 4 DOF. This clustering of cases early in the feeding period indicates that the animals were exposed to risk factors prior to, on the day of, or within a few days of arrival at the feedyard. However, treatments and deaths continued for many months into the feeding period. In these cases it is unlikely that TTNS was initiated early in the feeding period only to have clinical signs manifest many months later. Rather, a more likely scenario is that the late cases represent newly developing cases, which implies that the same constellation of risk factors may exist at multiple time points in the feeding period. For example, mustering cattle for reimplanting and/or revaccination may replicate the same conditions that animals encounter before or shortly after arrival at the feedyard.

Of the animals administered antimicrobial therapy for a putative diagnosis of TTNS, 25% were dead within 6 d. This rapid progression suggests that in some cases the disease may not be responsive to antimicrobial therapy or that the treatments were given too late. It was also of interest that 70% of animals died without having received antimicrobial therapy. These findings are not an indictment of the feedyard personnel. Rather, TTNS occurs as a lower limb lameness without obvious signs of swelling and hence cases may be misdiagnosed as traumatic injuries, which typically do not warrant antimicrobial therapy. These data underscore that the disease can be difficult to accurately diagnose clinically, unless time and effort are made to restrain the animal and perform a close inspection of the foot. This is logistically challenging and hence we suspect that early cases of TTNS are probably being misdiagnosed and underreported. This is of concern because a diagnosis of TTNS changes how the animals should be treated (i.e., aggressive debridement, claw amputation, antimicrobial therapy) and also changes the prognosis. Once the P3 bone is affected, then aggressive therapy such as claw amputation is often required to salvage the animal. If this course of action is not taken, then euthanasia must be considered.

One of the presumptive risk factors for TTNS is handling cattle on abrasive surfaces such as stamped, etched, or wet concrete. Mason et al (8) described an outbreak of hoof lesions in dairy heifers, which included white line separation and toe abscesses. Unlike feedyard cattle, these dairy heifers did not develop lesions until 2 mo after arrival at the dairy. The foot lesions were attributed to the heifers being fed on a wet and coarse concrete feed pad and being commingled with adult cows. Commingling of the heifers and cows was thought to have agitated the heifers, which may have contributed to the outbreak. This is of interest because hyper-excitability has been suggested as a possible risk factor for TTNS in feedyard cattle (7, 11). Conceivably, mustering fractious cattle on abrasive flooring may result in excessive wear along the apical region of the white line, leading to white line separation. If the texture (abrasiveness) of the flooring is an important risk factor, then the accumulation of manure, snow, and ice may alter the surface textures, which could explain the apparent ephemeral nature of the disease.

While exposure to abrasive flooring during transport, at auctions, or in feedyards may account for the clustering of cases.
The biomechanical properties of the hoof must also be considered as a potential factor in the development of the disease. Hoof horn tissue is very dynamic with respect to its ability to hydrate and dehydrate (15), which in turn influences its hardness and elasticity (15–17). This has clinical significance because increasing moisture content of solar horn has been associated with wear and thinning of the soles and indirectly with white line separation (18). This is salient because wet environmental conditions have been posited as a risk factor for TTNS (7). If this is correct, then the disease may be clustering within cohorts of animals coming off wet pastures, or being exposed to wet environmental conditions at auctions and feedyards. Furthermore, these conditions would change with time, helping to explain the sporadic nature of the disease.

Other factors that influence hoof hardness are the pigmentation of the horn tissue and the animal’s nutritional status. Hoof hardness has been shown to increase with the level of pigmentation (15) and micronutrients are important for maintaining the integrity of the hoof horn (15,19–21). Given the myriad of factors that could potentially influence the rate of wear to the soles, it is perhaps not surprising that the disease occurs sporadically but clusters by lot and feedyard.

Most of the TTNS lesions were found in the hind feet; however, lesions occasionally occurred in the front feet. The prediction for TTNS to occur in the hind feet was consistent with previous reports (5–7). However, consistent with most previous reports, Smith and Brodersen (22) reported TTNS-like lesions that primarily involved front feet. This latter report underscores that veterinarians and feedyard crews need to be cognizant that TTNS may also account for forelimb lameness.

Most cases involved auction-derived cattle, steers, and yearlings. However, these findings probably reflect the proportion of auction-derived cattle, steers, and yearlings fed over the 5-year study period. Similarly, most cases occurred in the months of September to December, which coincides with when cattle typically enter the feedyard. Therefore, there was probably no seasonal effect per se; rather, the seasonality was confounded by when cattle enter the feedyards. The overriding conclusion from the individual animal data is that TTNS can develop in calves and yearlings; steers and heifers; and in all months of the year.

The Kaplan-Meier analysis provided a graphical representation of when the animals died after entering the feedyard. It must be stressed that without a control group the graphs only convey the timing of the deaths in the feedyard; no conclusions can be drawn as to whether source was a risk factor for the occurrence of the disease. While the backgrounded cattle survived longer in the feeding period than did the cattle from the other 3 sources, this finding may be spurious and therefore must be interpreted with caution. There was no difference in the 4 survivor functions in the first 100 DOF, a period when 90% of all cattle died. Therefore, if source had an effect on the speed of the progression of the disease, then it was largely masked by other factors in the first 100 DOF. However, the divergence of the survival curve for the backgrounded cattle from the other groups is intriguing and deserves additional study.

There were a number of limitations to this study. Only lots of > 100 head were included so as to avoid a small number of cases skewing the lot prevalence data. Larger lots were also chosen because producers and auction markets frequently sort less thrifty cattle into smaller lots, which could have introduced other biases. Only 1 y of lot prevalence data were analyzed, which may have influenced the results. All the records were obtained from clients of FHMS and their recommendations for when and how to treat lame cattle may or may not represent what is occurring across the North American feedlot industry. It also needs to be emphasized that some of the clustering of cases in time and space may be related to a detection bias, with some feedlot personnel being more capable and vigilant when it comes to detecting TTNS cases.

Despite the limitations, this was the first study dedicated to describing the epidemiology of TTNS in North American feedyard cattle. The data confirm anecdotal reports that the disease is sporadic, but clusters in time, by lot, and by feedyard. Clustering early in the feeding period suggests that TTNS is initiated prior to, during, or shortly after arrival at the feedyard. Clustering by lot may be related to the cohorts sharing common attributes such as temperament, environmental (wet) conditions, nutritional status, and claw pigmentation (breed). Conversely, clustering by feedyard portends the potential for feedyard-specific factors such as facility design, flooring, animal handling, and the ability of the feedyard crews to identify and treat cases early in the course of the disease. Lastly, it was salient that the number of TTNS cases had decreased significantly over the 5-year time period. This reduction may be related to changes in how lame cattle are being identified and/or treated. A well-designed prospective study is needed to determine the true prevalence of the disease as well as provide greater clarity on potential risk factors.
References


Erratum

CVJ 2015;56:1025–1028

Abnormal changes in both mandibular salivary glands in a dog: Non-mineral radiopaque sialoliths


The corresponding author for this article is Hwi-Yool Kim not Dae-Hyun Kim.
Augmentation of arthrodesis in dogs using a free autogenous omental graft

Jennifer J. Ree, Wendy I. Baltzer, Katy L. Townsend

Abstract — A technique for using free autogenous omental grafting with arthrodesis in dogs is described and radiographic osseous union and complications after surgery are evaluated. This retrospective study matched body weight and procedure type for 8 cases of pancarpal arthrodesis, 4 cases of pantarsal arthrodesis, and 2 cases of partial tarsal arthrodesis in dogs with omental and cancellous bone autograft (OBG group) and with cancellous bone autograft alone (BG group). Radiographs were reviewed 9 to 12 weeks after surgery to compare scores of radiographic osseous union and it was found that the OBG group had higher scores than the BG group. The BG group had significantly more major complications that required re-operation for implant removal or treatment of a deep infection compared to the OBG group. Overall, free autogenous omental grafts may be used to augment arthrodesis in dogs without significant morbidity and further investigation of its use to reduce major complications and speed bone healing are warranted.

Résumé — Augmentation de l’arthrodèse chez les chiens en utilisant une greffe omentale autogène libre. Cette étude décrit une technique de l’utilisation d’une greffe omentale autogène avec une arthrodèse chez les chiens et elle évalue l’union osseuse radiographique et les complications après la chirurgie. L’étude rétrospective a jumelé le poids corporel et le type d’intervention pour 8 cas d’arthrodèse pancarpienne, 4 cas d’arthrodèse pantarsienne et 2 cas d’arthrodèse partielle du tarse chez des chiens avec une autogreffe de l’os spongieux (groupe OBG) et avec une autogreffe de l’os spongieux seulement (groupe BG). On a évalué les radiographies de 9 à 12 semaines après la chirurgie pour comparer les notes d’union osseuse radiographique et on a constaté que le groupe OBG avait des notes supérieures à celles du groupe BG. Il s’est produit un nombre significativement supérieur de complications majeures dans le groupe BG qui ont exigé une nouvelle opération pour l’enlèvement de l’implant ou le traitement d’une infection profonde comparativement au groupe OBG. En général, les greffes omentales autogènes libres peuvent être utilisées pour augmenter l’arthrodèse chez les chiens sans morbidité significative et de nouvelles études de leur utilisation pour réduire les complications majeures et accélérer la guérison osseuse sont justifiées. (Traduit par Isabelle Vallières)

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Introduction

Carpal and tarsal arthrodeses are performed as salvage procedures following injuries resulting in joint instability and lameness in dogs (1–3). Recommended arthrodesis techniques include bone plating, pinning, and external skeletal fixation with or without external coaptation until radiographic signs of osseous union are documented (4–13). Complications have been reported in 30% to 70% of cases including discharging sinuses or tracts, osteomyelitis, implant loosening, infection, metacarpal/metatarsal fracture, implant failure, and plantar necrosis (1,2,4,5,10,13–17). With such a high frequency of complications, methods of improving healing and reducing complications are needed.

Historically, the reported time to osseous fusion of a pancarpal arthrodesis is between 6 and 12 wk and maximal radiographic bone bridging is between 6 to 8 wk in most dogs (4,5,17). However, Bristow et al (3) recently showed in a retrospective study that complete radiographic bony union with hybrid arthrodesis plates and CastLess plates occurred at a mean of 32 ± 66 wk and 21 ± 18 wk, respectively, suggesting that historical reports may have underestimated the time required for radiographic bony union. With such a prolonged healing
These approaches have had mixed success in grafts made of hydroxyapatite and collagen, and bioartificial composite bone allogenic bone graft, demineralized bone matrix, increase the cost and time required for treatment. Externally coaptation, however, may increase the risk of complications such as cast sores, infection, and disuse atrophy, which can increase the cost and time required for treatment.

Materials reported to stimulate bone bridging with arthrodesis include allogenic bone graft, demineralized bone matrix, recombinant bone morphogenic protein, novel biomaterials (hydroxyapatite and collagen), and bioartificial composite bone grafts made of β-tricalcium phosphate and platelet rich plasma. These approaches have had mixed success in improving the arthrodesis rate and reducing operative or postoperative complications in dogs and the cost of some products may be prohibitive.

Free autogenous greater omental graft may provide an alternative to other methods to enhance bone healing and stimulate osteogenesis in dogs that is inexpensive and not technically demanding. Free autogenous omentum wrapped around an experimental gap radial osteotomy in dogs without other stabilization resulted in complete union at 16 wk after surgery. Free autogenous omental grafting has been reported to augment healing of radius and ulna fractures in toy and miniature breed dogs with reduced time to complete bone bridging and fewer major complications compared with similarly sized dogs without free autogenous omental grafting.

Omentum has been used in extracelomic locations in human medicine to help fill soft tissue defects, defend against infection, and provide vascular support for bone and skin grafts. It has also been used to spontaneously form anastomosis and revascularization of tissues that it contacts. Omentum placed in experimentally created femoral bone defects in rabbits resulted in improved angiogenesis and bone revascularization with increased osteogenic cells in the defect following grafting.

The first objective of this retrospective study was to describe the technique for omental grafting in arthrodesis procedures. The second objective was to compare osseous union and complications following arthrodesis of the carpus or tarsus with and without implantation of omental graft in pairs of dogs matched for body weight and type of arthrodesis. Our hypothesis was that augmentation of internally stabilized partial or panarthrodesis of the carpus or tarsus in dogs with omental graft in addition to cancellous bone autograft would result in improved scores of radiographic osseous union and reduced complications after surgery compared with dogs receiving only cancellous bone autograft without omental graft.

Materials and methods

The medical records from Lois Bates Acheson Small Animal Veterinary Teaching Hospital at Oregon State University were retrospectively reviewed from July 2006 to July 2014 to include all dogs with a partial or panarthrodesis of the carpus or tarsus. Dogs with partial or panarthrodesis of the carpus or tarsus using a variety of stainless steel bone plates were included in the study. Dogs with omental graft and cancellous bone autograft (OBG group) were case matched by weight and surgical procedure to dogs with cancellous bone autograft (BG) alone (BG group). Exclusion criteria included dogs with: neurologic dysfunction, other orthopedic disease in the same limb, signs of systemic disease, or other surgical procedures performed at the same time as arthrodesis. Signalment, body weight, indication for surgery, method of arthrodesis, and type of internal fixation were recorded for each dog.

The surgical technique for arthrodesis employed a dorsal midline or lateral approach to either the carpal or tarsal joint as well as exposure of the joint surfaces. An appropriately sized burr was used with a pneumatic drill (Hall Surgairtome II; ConMed Linvatec, Utica, New York, USA) to remove articular cartilage from the joint surfaces. All dogs received cancellous bone autograft at the site of arthrodesis obtained from the proximal humerus followed by stabilization with a variety of stainless steel bone plates at the discretion of the surgeon. For the OBG group, a 2 to 3 cm laparotomy was performed at the ventral midline or paramedian (using a grid approach). A 4 to 6 cm² portion of greater omentum was isolated, ligated with an encircling ligature of 2-0 or 3-0 absorbable suture, and transected. The free autogenous omental graft was implanted over the bone plate with particular attention to omentum-bone contact proximal, distal, medial, and lateral to the bone plate (Figure 1). Closure was composed of at least 2 layers (subcutaneous and intradermal/skin). Due to the size of the free autogenous omental graft, the subcutaneous layer was closed with simple interrupted absorbable sutures while the graft was held in place using a Freer periosteal elevator. Omentum was commonly seen external to the skin incision and any graft that could not be replaced into the subcutaneous layer was transected using Metzenbaum scissors prior to intradermal and skin suture. External coaptation with a custom fiberglass splint was employed for at least 4 wk following surgery at the discretion of the attending surgeon. The splints were applied caudally for carpal arthrodesis and laterally for tarsal arthrodesis and replaced once or more often per wk.

Radiographs were obtained at 5 to 8 wk after surgery for most dogs and every 2 to 4 wk until radiographic osseous union had occurred or the dog was lost to radiographic follow-up. If follow-up was not at the original institution, referral hospitals...
were contacted to obtain records and radiographs pertaining to the original surgery. Radiographic scores were calculated for all radiographs obtained within 9 to 12 wk after surgery in accordance with the scale established by Michal (Table 2) (17). The scores for each of the operated joints were averaged for each radiograph and observer. All radiographs were reviewed by 2 diplomates of the American College of Veterinary Surgeons (WIB, KLT) blinded to the treatment group for evidence of osseous fusion of the joints, implant failure, and complications. The scores from both observers were averaged for comparison between the 2 groups.

Complications were identified from the medical records and radiographs. Major complications were categorized as those that resulted in reoperation (radiographic signs of osteomyelitis requiring implant removal and culture, implant loosening, implant failure and/or removal, wound dehiscence, screw protrusion through the skin, and amputation). Minor complications were categorized as those that needed veterinary attention but did not require additional surgery (pressure sores, swelling and edema, serous discharge from the incision, osteopenia, persistent lameness, cold intolerance, and licking skin over the implants following complete bone union).

### Table 1. Results of analysis between omental graft and cancellous bone autograft (OBG) and cancellous bone autograft (BG) groups

<table>
<thead>
<tr>
<th>Breed</th>
<th>Age (years)</th>
<th>Body weight (kg)</th>
<th>Gender</th>
<th>Graft type</th>
<th>Procedure</th>
<th>Minor complications</th>
<th>Major complications</th>
<th>Follow-up time (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard poodle</td>
<td>13</td>
<td>26</td>
<td>FS</td>
<td>OBG</td>
<td>Pantarsal</td>
<td>Swelling, vomiting, diarrhea</td>
<td>—</td>
<td>11</td>
</tr>
<tr>
<td>Mixed breed</td>
<td>3</td>
<td>21.5</td>
<td>MN</td>
<td>BG</td>
<td>Pantarsal</td>
<td>—</td>
<td>Implant removal for persistent draining tract</td>
<td>165</td>
</tr>
<tr>
<td>German shorthaired point</td>
<td>3</td>
<td>31</td>
<td>FI</td>
<td>OBG</td>
<td>Partial tarsal</td>
<td>Lameness</td>
<td>Implant removal per owner request</td>
<td>11</td>
</tr>
<tr>
<td>Australian shepherd mix</td>
<td>3.5</td>
<td>30</td>
<td>FS</td>
<td>BG</td>
<td>Partial tarsal</td>
<td>Osteopenia</td>
<td>—</td>
<td>3</td>
</tr>
<tr>
<td>Alaskan malamute</td>
<td>6</td>
<td>31.6</td>
<td>FS</td>
<td>OBG</td>
<td>Pancarpal</td>
<td>Osteopenia, micromotion</td>
<td>—</td>
<td>14</td>
</tr>
<tr>
<td>Husky mix</td>
<td>10</td>
<td>31.8</td>
<td>FS</td>
<td>BG</td>
<td>Pancarpal</td>
<td>Micromotion</td>
<td>—</td>
<td>3</td>
</tr>
<tr>
<td>Mixed breed</td>
<td>4</td>
<td>35.6</td>
<td>FS</td>
<td>OBG</td>
<td>Pancarpal</td>
<td>Lameness, swelling</td>
<td>—</td>
<td>13</td>
</tr>
<tr>
<td>Labrador retriever</td>
<td>3</td>
<td>37</td>
<td>MN</td>
<td>BG</td>
<td>Pancarpal</td>
<td>Seroma, bandage sores</td>
<td>Drain placed for infection at graft site</td>
<td>2</td>
</tr>
<tr>
<td>Labrador retriever</td>
<td>1</td>
<td>31.9</td>
<td>M</td>
<td>OBG</td>
<td>Pancarpal</td>
<td>Lameness, superficial infection</td>
<td>—</td>
<td>5</td>
</tr>
</tbody>
</table>

### Table 2. Scores of radiographic osseous union for the 9- to 12-week time interval for patients with available radiographs

<table>
<thead>
<tr>
<th>Breed</th>
<th>Procedure</th>
<th>Graft type</th>
<th>Time of radiographs (weeks)</th>
<th>Observer 1</th>
<th>Observer 2</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>German shorthaired pointer</td>
<td>Partial tarsal</td>
<td>Omentum</td>
<td>11</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Australian shepherd mix</td>
<td>Partial tarsal</td>
<td>Bone</td>
<td>12</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Alaskan malamute</td>
<td>Pancarpal</td>
<td>Omentum</td>
<td>11</td>
<td>2</td>
<td>2.67</td>
<td>2.334</td>
</tr>
<tr>
<td>Husky mix</td>
<td>Pancarpal</td>
<td>Bone</td>
<td>12</td>
<td>1</td>
<td>2.33</td>
<td>1.667</td>
</tr>
<tr>
<td>Labrador retriever</td>
<td>Pancarpal</td>
<td>Omentum</td>
<td>10</td>
<td>2.67</td>
<td>2</td>
<td>2.334</td>
</tr>
<tr>
<td>Husky mix</td>
<td>Pancarpal</td>
<td>Bone</td>
<td>10</td>
<td>1.33</td>
<td>1</td>
<td>1.167</td>
</tr>
<tr>
<td>German shepherd</td>
<td>Pancarpal</td>
<td>Omentum</td>
<td>9</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>German shepherd</td>
<td>Pancarpal</td>
<td>Bone</td>
<td>11</td>
<td>0.67</td>
<td>1.3</td>
<td>1</td>
</tr>
<tr>
<td>Border collie</td>
<td>Pancarpal</td>
<td>Omentum</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Labrador retriever</td>
<td>Pantarsal</td>
<td>Omentum</td>
<td>12</td>
<td>1.667</td>
<td>1.667</td>
<td>1.667</td>
</tr>
</tbody>
</table>

### Notes
- **Table 1**
  - Breed: Labrador retriever, German shepherd mix, Alaskan malamute, Husky mix, Mixed breed, Labrador retriever
  - Procedure: Pantarsal, Partial tarsal, Pancarpal, Omentum, Bone
  - Graft type: OBG, BG
  - Minor complications: Swelling, vomiting, diarrhea, Osteopenia, Micromotion
  - Major complications: Implant removal for persistent draining tract, Implant removal per owner request
  - Follow-up time (months): 11, 165, 11, 3, 14, 3, 13, 2, 5

### Table 2
- **Breed**
  - German shorthaired pointer, Australian shepherd mix, Alaskan malamute, Husky mix, Mixed breed, Labrador retriever
- **Procedure**
  - Partial tarsal, Pantarsal, Pancarpal, Omentum, Bone
- **Graft type**
  - Omentum, Bone
- **Time of radiographs (weeks)**
  - 11, 12, 11, 10, 10, 9, 11, 12
- **Observer 1**
  - 2.5, 1.5, 2, 2.67, 1.33, 3, 0.67, 1.667
- **Observer 2**
  - 2.5, 1.5, 2, 2.334, 1, 3, 1.3, 1.667
- **Mean**
  - 2.5, 1.5, 2.334, 1.667, 1.167, 3, 1, 1.667

### Notes
- **Scores of radiographic osseous union**
  - Reference: 17
  - 0 = No mineralized (bone) tissue visible in the joint space
  - 1 = Cancellous bone bridging the joint space but joint space still clearly visible
  - 2 = Bony bridging of joint space but subchondral bone plate still clearly visible
  - 3 = Solid fusion of adjacent bone with modeling of bone and loss of subchondral bone plate
- **Statistical analysis**
  - Performed using an unpaired Student's t-test, two-tailed
  - OBG: 2.5 ± 0.16; BG: 1.4 ± 0.14; P = 0.0009
  - Graphpad Prism 5.0a
- **Follow-up time**
  - 11, 165, 11, 3, 14, 3, 13, 2, 5 weeks
- **Radiographs**
  - For patients during the 9- to 12-week time period were not available for review
  - Graphpad Prism 5.0a
Results were analyzed with an unpaired two-tailed Student’s t-test to detect differences between the 2 groups. Results were considered significant if the P-value was < 0.05 (Graphpad Prism 5.0a, La Jolla, California, USA).

Results
Twenty-six dogs met the inclusion criteria: 8 in the OBG group and 17 in the BG group. One of the OBG group dogs did not have a case-controlled BG group match and was excluded. The remaining 7 OBG group dogs were case-matched by weight and procedure to 7 BG group dogs.

The mean age of all dogs was 5.4 y [OBG: 5.0 ± 1.5 y, BG: 5.8 ± 1.2 y, mean ± standard error of the mean (SEM)]. The mean body weight of all dogs was 32.6 kg [OBG: 29.4 ± 2.2 kg, BG 35.7 ± 3.2 kg, mean ± SEM]. There was no significant difference in age or weight between the groups [P = 0.688, 95% confidence interval (CI): −3.37 to 4.94; P = 0.130, 95% CI: −2.15 to 14.72, respectively] (Table 1). Breeds included Labrador retriever (n = 3), German shepherd (n = 2), mixed breed (n = 2), Husky mix (n = 2), and 1 each of the following: standard poodle, German shorthaired pointer, Alaskan malamute, border collie, and Australian shepherd mix. Both groups had similar variation in the surgical procedures performed: 4 pancarpal arthrodeses, 2 pantarsal arthrodeses, and 1 partial tarsal arthrodesis (Table 1). The mean time (± SEM) for follow-up in all dogs was 10.1 ± 1.2 mo for OBG dogs and 36.5 ± 26.5 mo for BG dogs with no significant difference between the groups (P = 0.302, 95% CI: −27.3 to 80.0) (Table 1).

Indications for arthrodesis included carpal hyperextension (5 dogs; 2 OBG group, 3 BG group), intra-articular fracture (4 dogs; 2 OBG group and 2 BG group), luxation or subluxation (3 dogs; 1 OBG group and 2 BG group), metacarpal

Figure 2. Orthogonal radiographs of BG group dog with pan-carpal arthrodesis. Cranial-caudal (A) and mediolateral (B) pre-operative images. Cranial-caudal (C) and mediolateral (D) immediately post-operative images. Cranial-caudal (E) and mediolateral (F) images at 11 wk post-surgery.

Figure 3. Orthogonal radiographs of OBG group dog with pan-carpal arthrodesis. Cranial-caudal (A) and mediolateral (B) pre-operative images. Cranial-caudal (C) and mediolateral (D) immediately post-operative images. Cranial-caudal (E) and mediolateral (F) images at 10 wk post-surgery.
fractures (1 dog; OBG group), failed gastrocnemius tendon rupture repair (1 dog; OBG group), angular limb deformity correction (1 dog; OBG group), severe osteoarthritis (1 dog; BG group), and failure of previous arthrodesis surgery (1 dog; BG group). Three dogs had multiple injuries of the affected joint including fracture with luxation or subluxation (2 dogs; 1 OBG group and 1 BG group) or fracture with hyperextension (1 dog; BG group).

Radiographs were available for review in 13 dogs (6 OBG dogs, 7 BG dogs) throughout the entire follow-up period (between 5 wk and 62 mo after surgery, Figures 2 and 3). Only 9 dogs (4 OBG dogs, 5 BG dogs) had radiographs available between 9 and 12 wk after surgery. Only these dogs were used in comparison of inter-observer variability for the scores of radiographic osseous union (Table 2) (17). There was no significance difference between the observers ($P = 0.599$, 95% CI: $-0.55$ to $0.92$). By comparing the average scores of radiographic osseous union from the 2 observers, a significant difference between the 2 groups was identified (OBG 2.5 ± 0.16, BG 1.4 ± 0.14; $P < 0.001$, 95% CI: $-1.63$ to $-0.65$) (Table 2).

Complications were identified in each group (Table 1). Minor complications were recorded in 42% of the BG group and 100% of the OBG group and were not significantly different between the 2 groups ($P = 0.055$, 95% CI: $-0.01$ to $0.87$). Minor complications included lameness, swelling, erythema, minor serous incisional discharge, or bandage sores, which were responsive to medical management (Figure 4). Major complications were recorded in 71.4% of the BG group and 14.2% of the OBG group and were significantly different between the 2 groups ($P = 0.031$, 95% CI: $-1.10$ to $-0.06$). Major complications included radiographic signs of osteomyelitis and implant loosening that required implant removal, implant loosening, breakage, or owner request that required subsequent anesthetic procedures and removal of implants (Figure 5).

Discussion

To the authors’ knowledge, this is the first time arthrodesis repair of the carpus or tarsus has been described using augmentation with a free autogenous omental graft. In this small group of dogs, augmentation of internally stabilized partial or panarthrodesis of the carpus or tarsus with not only cancellous bone autograft but also free autogenous omental graft resulted in improved radiographic scores of osseous union with reduced major complications compared to the dogs that received cancellous bone autograft only. Expanding these results to the general population of dogs requiring arthrodeses would require further study, such as a prospective randomized, controlled clinical trial with a larger group of dogs.

A recent retrospective study described the use of a free autogenous omental graft in radius and ulna fractures of toy breed dogs and similarly found fewer major complications and reduced time to complete bone bridging (25). Activated and cultured omentum produces large amounts of vascular endothelial growth factor (VEGF), which can enhance the recovery of various organs following injury (28). Experimental bone nonunion models in dogs and rabbits have shown improved bone and callus production and reduced nonunion with omental graft implantation (24, 27). Experimental free omentum grafting in rabbits following tibial bone osteotomy causes a doubling of capillary buds entering the bone defect and reduction in the defect size through release of growth factors including VEGF, basic fibroblast growth factor, and transforming growth factor-$\beta$; all of which are reported to have positive effects on bone repair and healing (29–32). Induction of osteogenic cells is suspected to be influenced by these local omental-derived growth factors leading to angiogenesis and bone synthesis (27). Since addition of cancellous bone autograft to the arthrodesis site increases bone bridging histologically at 12 wk after surgery (23), we suggest

![Figure 4](image_url) Example of dog from the OBG group with erythema, swelling, and edema that was responsive to frequent bandage changes within 7 days after surgery.

![Figure 5](image_url) Mediolateral radiographs of a dog from the BG group with loosening of the implant requiring implant removal 4 months after surgery.

![Figure 6](image_url) Orthogonal radiographs of a dog from the OBG group whose owner requested removal of the plate 13 months after surgery. A – cranio-caudal view, B – mediolateral view.
that further augmentation with a free autogenous omental graft may be beneficial in arthrodesis procedures to reduce time to osseous union following arthrodesis (24). Following vascularization, omentum stromal cells with progenitor and embryonic cell markers, in addition to the growth factors, stimulate mineralization without fibrous tissue and endochondral ossification at fracture gaps (24,33,34).

In the present study, radiographic evaluation at the 9 to 12 wk post-operative time period was used as a clinical measure of osseous union. Arthrodeses have been documented to take up to 12 wk to complete radiographic osseous union and incomplete osseous union is reported most commonly within the first 12 wk after surgery (4,5,17). More recently, significant osseous union of carpal arthrodeses has been reported to occur in the first 6 to 8 wk then ossification plateaus during the following 8 to 12 wk. In some cases, isopaque bone union takes place > 30 wk after surgery (17). A recent retrospective report found only 40% to 46% of cases were healed at a mean follow-up period of 30 to 41 wk (3). The length of follow-up required after arthrodesis can deter owners from appropriate documentation of radiographic bony union, especially if the dog is clinically doing well, and may have contributed to the lack of radiographic follow-up in many dogs in this study.

Due to the significant limitations attributable to the retrospective nature of this study and the small numbers of cases for comparison of radiographic healing and complication rates, it is not possible to definitively propose that autogenous free omental graft reduces time to osseous union or decreases the incidence of complications. The significance found in this study is minimal and may indicate a Type 1 statistical error. A more robust significance may be found if a larger study population is evaluated. However, in the small number of cases that had healing scores within the 9- to 12-week period, OBG group dogs had higher scores than those in the matched BG group dogs. This may infer that time to osseous union may be reduced if augmentation with OBG is performed at the time of arthrodesis. A prospective, blinded randomized clinical trial of augmentation of carpal or tarsal arthrodesis with sequential radiography and follow-up is warranted to accurately determine the time to osseous union, outcome, lameness, and owner satisfaction. The reduced rate of radiographic signs of osteomyelitis and reduced incidence of implant failure may be due to improved soft tissue coverage from the free greater omentum autograft, improved immune function due to the presence of lymphoreticular bodies in the omentum containing macrophages, B-cells, T-cells, plasma cells, and mesenchymal stromal stem cells, reduced time to osseous union, or a combination of these factors (35).

Complications were documented in all dogs in this small study (N = 14). There was no significant difference in the incidence of minor complications between the groups; however, there was a significant difference in the incidence of major complications. The statistical data comparing minor complications (P = 0.055) may indicate a trend towards significance. The most common minor complication in the OBG group was swelling, erythema, and minor serous incisional discharge that was managed with daily bandage changes and typically resolved within 3 to 7 d after surgery. There was 1 major complication in the OBG group following partial tarsal arthrodesis where the owner requested plate removal 13 mo post-surgery because the dog was used in hunting, although no lameness, implant loosening, radiographic signs of osteomyelitis, osteopenia, or cold intolerance was ever documented in this dog (Figure 6). Since the implant removal was not clinically indicated, this major complication could have been removed from the statistical analysis and would increase the significance in the major complications reported herein (P < 0.001, 95% CI: −1.17 to −0.23). The dogs in the BG group with major complications involved implant failure or deep infections requiring implant removal or a second surgical procedure to debride infected tissue. A methicillin-resistant Staphylococcus pseudointermidius infection in 1 dog was initially managed medically but implant removal was performed 5 y after surgery due to recurrent draining tracts. None of the OBG dogs had radiographic evidence of osteomyelitis following surgery. Infection is a common cause of complications in carpal arthrodesis in dogs (3), and augmentation of this surgery with OBG to reduce the incidence of infection warrants further investigation.

Arthrodesis is a salvage procedure with complete loss of motion of the arthrodesed joint, which results in gait abnormalities that may be perceived as lameness (35). There was inconsistent use of plating techniques and both partial and panarthrodesis procedures were included in the report complicating analysis of the outcomes. Andreoni et al (35) showed that there was a significant difference in peak vertical force between pan and partial carpal arthrodesis. It would be critical to evaluate any possible objective and subjective differences in outcome measures of the different types of procedures and if there is variation between the carpus and the tarsus or between partial and panarthrodesis. The low numbers in this study preclude any evaluation of this data for this group of dogs.

In conclusion, free autogenous omental grafts may be used to augment carpal or tarsal arthrodesis in dogs without significant morbidity or mortality and may improve radiographic signs of osseous union as well as reduce the incidence of major complications. Further investigation of this technique to augment arthrodesis is recommended using a blinded prospective clinical trial.

References


Outcome and prognostic factors for dogs with a histological diagnosis of splenic hematoma following splenectomy: 35 cases (2001–2013)

Steve G. Patten, Sarah E. Boston, Gabrielle J. Monteith

Abstract — Canine splenic hematoma can be indistinguishable from hemangiosarcoma on clinical presentation and grossly at the time of surgery. However, hemangiosarcoma represents an aggressive malignancy and a misdiagnosis of hematoma would forgo indications for chemotherapy. This study describes a long-term follow-up of cases with a histologic diagnosis of splenic hematoma following splenectomy to determine if the clinical course of the disease corroborated the diagnosis. Thirty-five dogs were evaluated to determine survival and prognostic associations with signalment and clinical data. Overall median survival time was 647 days (range: 0 to 3287 days). Statistically significant variables included a palpable abdominal mass during physical examination, sub-clinical coagulopathy, and metastasis. Four cases (11%) had reported evidence of metastasis at the time of euthanasia; 1 case was histologically confirmed. Overall prognosis for splenic hematoma appears excellent, as expected, but a small proportion of cases may have an undiagnosed malignant component.

Résumé — Résultats et facteurs de pronostic pour les chiens ayant un diagnostic histologique d’hématomes spléniques après la splénectomie : 35 cas (2001–2013). L’hématome splénique canin peut être indifférenciable de l’hémagiosarcome à la présentation clinique et macroscopiquement au moment de la chirurgie. Cependant, l’hémagiosarcome représente une malignité agressive et un mauvais diagnostic de l’hématome se traduirait par l’absence de chimiothérapie. Cette étude décrit un suivi à long terme des cas avec un diagnostic histologique de l’hématome splénique après la splénectomie afin de déterminer si l’évolution clinique de la maladie a corroboré le diagnostic. Trente-cinq chiens ont été évalués afin de déterminer les associations de survie et de pronostic avec le signalement et les données cliniques. La durée de survie médiane globale était de 647 jours (fourchette de 0–3287 jours). Les variables statistiquement significatives incluaient une masse abdominale palpable à l’examen physique, une coagulopathie subclinique et la présence de métastases. Quatre cas (11 %) avaient signalé la présence de métastases au moment de l’euthanasie; 1 cas a été confirmé par histologie. Le pronostic général pour un hématome splénique semble excellent, mais une faible proportion de cas peut présenter un élément de malignité non diagnostiqué.

(Traduit par Isabelle Vallières)

Introduction

Differential diagnoses for a canine splenic mass include malignant tumors such as hemangiosarcoma, lymphoma, histiocytic sarcoma, and other sarcomas (1,2) as well as benign masses including splenic hematoma, and lymphoid hyperplasia. Hemangiosarcoma is a malignancy arising from endothelium and is the most common neoplasm of the canine spleen (2,3). One study led to the development of the so-called two-thirds rule: approximately 2/3 of splenic masses will be malignant, and 2/3 of those will be hemangiosarcoma; the remaining 1/3 of splenic masses would be expected to be benign (4). Other studies have reported a 50% chance of malignancy without the presence of hemoperitoneum, with hemangiosarcoma the most common malignancy (2,5). The most common benign splenic lesion reported in dogs is splenic hematoma (3,6). Canine splenic hematoma and hemangiosarcoma can have a similar clinical presentation and gross appearance at the time of surgery. This is because a hematoma is a component of most splenic hemangiosarcomas. However, the prognosis of these 2 conditions is very different, with a poor prognosis in canine splenic hemangiosarcoma due to early and aggressive metastasis (7). With splenectomy alone, the reported median survival time is 86 d with an estimated 1-year survival rate of 6.25% (8). A more recent study reported a median survival time of 1.6 mo with 11.1% alive at 1 y and 4% alive at 2 y following splenectomy alone (3). Histopathology is required to differentiate hemangiosarcoma...
from hematoma. In cases in which the signalment is commonly associated with hemangiosarcoma, older and large breed dogs (1), a histological diagnosis of splenic hematoma can still create doubt for the clinician as to whether or not hemangiosarcoma is present, but was not included on histological sectioning. This is especially true if a large component of the splenic mass was a hematoma grossly.

The objective of this study was to retrospectively determine outcome and prognostic factors associated with a histological diagnosis of splenic hematoma following splenectomy in dogs. Secondary aims were to evaluate the potential to predict when cases may have been misclassified as hematoma, by evaluating clinical data to look for prognostic factors, which may be used to increase the clinical suspicion of malignancy rather than a benign splenic hematoma.

Materials and methods

Medical records at our veterinary teaching hospital were reviewed, retrospectively, for 35 dogs with a histopathological diagnosis of splenic hematoma following splenectomy during the period February 2001 to February 2013. The entire spleen was formalin-fixed and available for histopathologic evaluation via standard hematoxylin and eosin staining methods. A board-certified pathologist performed all histopathology. Potential prognostic factors including signalment and clinical data including gender, breed, body weight, splenic mass volume, hemorrhagic peritoneal effusion, anemia, blood transfusion, coagulation parameters, and palpable mass were collected from the medical records and evaluated for associations with survival or whether or not evidence of confirmed or suspected metastasis was determined, employing both univariate and multivariate analyses. Anemia and thrombocytopenia were defined as values below the normal reference range. All blood values were determined at the time of admission. Splenic mass volume was calculated via linear measurements in 3 dimensions of the splenic mass on the gross specimen following splenectomy. Outcome was determined through follow-up with referring veterinarians and owners. Patients in which no follow-up data were available and/or were still alive at the time of this study were censored from the final statistical analyses. Survival time was determined as the time between surgery and death and was reported using Kaplan-Meier survival curves. A Cox Proportional Hazard Model was employed to compare variables with survival data. Clinical variables were analyzed as likelihood estimates of affecting median survival time using both univariate and multivariate analyses. The Wilcoxon test, which places more weight on early survival times, is reported for palpable abdominal mass. Otherwise the score test is reported. Statistical significance was defined as P ≤ 0.05.

Results

The mean age at time of surgery was 10.1 y (range: 6.0 to 18.8 y). There were 54% castrated males and 46% spayed females (no intact animals were evaluated). The mean body weight was 29.8 kg (range: 6.4 to 59.1 kg). Three small breed dogs (< 10 kg) were included. No specific breed predilections were determined to be statistically significant prognostic indicators, although German shepherds (4/35; 11.3%) and Labrador retrievers (2/35; 6%) were the most common breeds represented. A historical and associated traumatic event was reported in only 3/35 dogs (9%); all 3 events consisted of a fall down the stairs prior to identification of a splenic mass but it is unknown whether a splenic mass existed prior to the traumatic event in any of these 3 cases. Three-view thoracic radiographs were taken in 27/35 (77%) dogs before splenectomy with no evidence of pulmonary metastasis reported in any case. A board-certified radiologist reviewed all thoracic radiographs. Abdominal ultrasound examination was also conducted in 27/35 (77%) dogs before surgery and ultrasonographic findings in all cases were consistent with a large, cavitated splenic mass +/- abdominal effusion with no other significant abnormalities within the peritoneal cavity. Cardiac ultrasounds were performed in 7 cases prior to surgery, no evidence of neoplasia and/or metastasis was reported in any of these patients. Two patients were diagnosed with mild mitral valve regurgitation secondary to mitral valve disease.

Hemorrhagic peritoneal effusion was present in 11/27 dogs (40%; based on abdominal ultrasound findings) and anemia was present in 17/35 dogs (48%). A blood transfusion was administered in 5/35 dogs (17%). Of the 11 dogs presenting with a hemorrhagic peritoneal effusion, 4 (36%) were given a blood transfusion. All patients received packed red blood cells. One patient received a blood transfusion after surgery for a hemorrhagic effusion secondary to a reported surgical complication. Concurrent hemorrhagic peritoneal effusion and anemic state was found in 8/35 (22%) cases. A coagulopathy was identified in 9/20 dogs (45%). This was defined as either a low platelet count (3/20 dogs; 15%) [2 were considered mild thrombocytopenias, and 1 was marked (19 × 10^9/L; reference interval: 117 to 418 × 10^9/L)], or elevated partial thromboplastin time (PTT) (7/20; 35%). One patient was mildly thrombocytopenic and had an elevated PTT. No clinical signs associated with coagulopathy were reported for any cases.

The overall median survival time (MST) was 674 d, with a range of 0 to 3287 d. Four patients were lost to follow-up; subsequently their survival data were censored.

Four dogs (11%) were euthanized for clinical signs and evidence of metastatic disease during the follow-up period. Clinical evidence of metastatic disease was reported in the referring veterinarian’s medical records at the time of euthanasia for 3 dogs. These 3 cases were not reassessed at our institution and histopathological confirmation of metastasis was not available. Two of these dogs had radiographic evidence of pulmonary metastasis and were euthanized by their primary care veterinarian. These cases included a 9-year-old castrated male golden retriever and a 9-year-old spayed female English setter. Their survival times were 138 and 329 d, respectively. The third case was a 13-year-old spayed female mixed breed dog (35 kg) which was presented to the primary care veterinarian with a hemorrhagic peritoneal effusion and had a hepatic mass based on abdominal ultrasound. This dog was also euthanized by the primary care veterinarian 522 d after splenectomy. Histopathologic confirmation of metastasis was not available for these 3 cases. The fourth case with evidence of metastatic disease re-presented to our hospital...
168 d after splenectomy in hypovolemic shock with evidence of a marked tri-cavitary (peritoneal, pleural, and pericardial) hemorrhagic effusion. This was a 10-year-old castrated male mixed breed dog that underwent splenectomy, for an incidentally found splenic mass following staging for an unrelated soft tissue sarcoma recut of the left shoulder area. Staging prior to splenectomy included three-view thoracic radiographs, thoracic computed tomography (CT) scan and abdominal ultrasound, with no evidence of metastasis reported. Original histologic evaluation of the spleen provided a diagnosis of splenic hematoma and nodular hyperplasia. This patient was euthanized on the day it re-presented for tri-cavitary effusion and postmortem examination confirmed diffuse metastatic hemangiosarcoma both grossly and histologically. Of these 4 cases of metastatic disease (3 suspected), 3 presented initially with evidence of an anemic state; only 1 of the 3 was diagnosed with a hemorrhagic peritoneal effusion, and none of them received a blood transfusion. The other 2 cases were most consistent with anemia of chronic disease. Thoracic radiographs were obtained in 3 of the 4 cases prior to splenectomy with no evidence of pulmonary metastasis. The survival time of the patient not receiving thoracic radiographs prior to surgery was 522 d; therefore, if misdiagnosed it would not be anticipated that gross pulmonary metastasis would have been present pre-operatively. The remainder of the study population died of causes unrelated to splenic hematoma. One dog included in the study cohort was euthanized in the immediate post-operative period. Extensive and uncontrollable hemorrhage was noted during a second exploratory laparotomy following exploratory laparotomy and splenectomy the previous day. Postmortem examination revealed evidence of disseminated intravascular coagulopathy presumed secondary to pancreatitis.

Survival was not influenced by signalment. Presence of a palpable abdominal mass during physical examination was a negative prognostic factor, while evidence of a sub-clinical coagulopathy, and suspected or confirmed metastasis through univariate analyses were statistically significant positive prognostic factors for overall survival (Table 1). Subsequently, a palpable abdominal mass would be more indicative of a misdiagnosis of hematoma over a malignancy. Other evaluated parameters, such as splenic mass volume, hemorrhagic peritoneal effusion, anemia, body weight, and blood transfusion were not statistically significant prognostic factors. Representative Kaplan-Meier survival curves are depicted for the variables of whether a palpable abdominal mass was present during physical examination, a documented sub-clinical coagulopathy, presence of (presumed or confirmed) metastasis, as well as overall survival (Figure 1); gender, splenic mass volume, evidence of hemorrhagic peritoneal effusion, blood transfusion were also analyzed but not depicted as Kaplan-Meier survival curves. The development of presumptive/confirmed metastatic disease was not influenced by the same clinical variables. No statistically significant correlations were determined via multivariate analyses. All combinations of the collected data were evaluated.

### Discussion

The reported MST of 674 d in our study, for dogs with a histopathological diagnosis of splenic hematoma, is longer than those previously reported. Two previous studies reported MST for splenic hematomas following splenectomy to be 338 d (9) and 252 d (5). Therefore, overall long-term survival with a diagnosis of splenic hematoma is excellent. It appears that a proportion of these cases may in fact be malignant cancer, with 4/35 (11%) in this series presenting with reported or confirmed clinical evidence of pulmonary metastasis (n = 2), hepatic (n = 1), or widespread (n = 1) metastasis. Unfortunately, histopathological confirmation of metastasis was not available in 3 of these cases and these reported lesions may have been the result of an alternate pathology. However, we believe that it is important to warn owners of the risk of misdiagnosis, and at the same time confer with the pathologists regarding the index of suspicion for a diagnosis of malignant splenic disease as this may warrant further histopathological investigation and scrutiny involving additional sectioning of tumor to definitively rule out a malignant component, especially given the association with concurrent (and potentially large) hematomas. In this study, the risk of this occurrence appears to be around 11%.

A previous study of splenic hematoma and hemangiosarcoma reported that 3/125 dogs originally diagnosed with splenic hematoma were reclassified to hemangiosarcoma following a

### Table 1. Parameters evaluated for survival of dogs diagnosed with splenic hematoma. P-values, hazard ratios, and 95% confidence limits are reported. Statistical significance was determined for the examined variables palpable abdominal mass during physical examination, coagulopathy, and suspected/confirmed metastasis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>n</th>
<th>P-value</th>
<th>Hazard ratio</th>
<th>95% Confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (male/female)</td>
<td>35</td>
<td>0.7733</td>
<td>0.879</td>
<td>0.365 - 2.117</td>
</tr>
<tr>
<td>Splenic mass volume (cm³)</td>
<td>24</td>
<td>0.842</td>
<td>0.950</td>
<td>0.735 - 1.229</td>
</tr>
<tr>
<td>Elevated ALP (yes/no)</td>
<td>32</td>
<td>0.4444</td>
<td>0.691</td>
<td>0.268 - 1.781</td>
</tr>
<tr>
<td>Hemorrhagic effusion (yes/no)</td>
<td>11</td>
<td>0.488</td>
<td>1.366</td>
<td>0.493 - 3.794</td>
</tr>
<tr>
<td>Anemia (yes/no)</td>
<td>35</td>
<td>0.972</td>
<td>0.953</td>
<td>0.403 - 2.254</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>35</td>
<td>0.817</td>
<td>0.996</td>
<td>0.969 - 1.023</td>
</tr>
<tr>
<td>Transfusion (yes/no)</td>
<td>5</td>
<td>0.293</td>
<td>0.527</td>
<td>0.173 - 1.608</td>
</tr>
<tr>
<td>Coagulopathy (yes/no)</td>
<td>20</td>
<td>0.0497</td>
<td>0.811</td>
<td>0.270 - 2.434</td>
</tr>
<tr>
<td>Palpable mass (yes/no)</td>
<td>35</td>
<td>0.0315</td>
<td>3.33</td>
<td>1.13 - 10.005</td>
</tr>
<tr>
<td>Metastasis (yes/no)</td>
<td>4</td>
<td>0.005</td>
<td>2.04</td>
<td>0.060 - 0.692</td>
</tr>
</tbody>
</table>

ALP — alkaline phosphatase.

* Represents log transformed data.

* Represents statistically significant variables (P < 0.05).
review of the slides by 2 independent pathologists (9). The 4 dogs in our study that died of presumptive or confirmed metastatic disease had survival times of 138, 168, 329, and 522 d.

In the current study, a palpable abdominal mass was a negative prognostic factor, while evidence of a sub-clinical coagulopathy, and development of confirmed or presumed metastasis were both positive prognostic factors for overall survival in univariate analysis. A previous study characterized the prevalence of splenic hemangiosarcoma (76.1%) and hematoma (23.9%) in a population of 71 dogs presenting with anemia and hemorrhagic peritoneal effusion requiring a transfusion and found that the need for a transfusion was strongly associated with a histological diagnosis of hemangiosarcoma (10). In our study, 3 of 4 dogs with death due to suspected or confirmed metastatic disease initially presented in an anemic state, 1 dog had evidence of hemorrhagic peritoneal effusion and none of them were treated with a blood transfusion. Subsequently, in contrast to this previous study, our results did not indicate that a blood transfusion acted as a significant factor in the suspected determination of malignancy versus a benign hematoma. This may have been the result of a smaller patient population in the present study, not allowing statistical significance to be reached. Another recent study showed that splenic hematomas had significantly higher mass-to-spleen volume ratio and a significantly increased splenic weight as a percentage of total body weight compared to malignant disease (11). Our study found that splenic mass volume was not significantly associated with overall survival. Absolute splenic mass volume was compared in the current study rather than mass-to-spleen volume. Splenic volume was not routinely recorded as part of the medical record.

Not every case included in the final analysis of this study had a coagulation profile performed, but of the 20 that did, 9 had evidence of a coagulopathy (thrombocytopenia, or prolonged PTT). A coagulation profile was not performed in the 4 cases with evidence of metastatic disease. Evidence of a sub-clinical coagulopathy cannot be correlated with the risk of a misdiagnosed malignant splenic disease but rather acts as a positive prognostic indicator for “true” splenic hematoma. Coagulopathy was a positive predictor of survival in univariate analysis only in this study. It is not clear whether or not splenic hematoma was a cause or an effect of the coagulopathies noted.

Whether there is a histological diagnosis of hemangiosarcoma or of hematoma, several breed predilections are reported, including Labrador and golden retrievers, German shepherds, and standard poodles (8,12,13). Though breed was not statistically significant as a prognostic factor, both Labrador retrievers and German shepherds were most commonly represented in our study. Therefore, breed does not appear to be useful in predicting a diagnosis of hematoma versus malignant splenic disease, such as hemangiosarcoma.

In our study, 11% of the cases had reported evidence of presumptive or confirmed metastatic disease at the time of death. A recent study reported a median survival time of 5.5 mo for stage I (confined to the spleen with no evidence of hemoabdomen).
hemangiosarcoma (3). The survival times for 2 of the dogs with presumptive metastasis, treated with splenectomy alone, were 329 and 522 d. One of these dogs had pulmonary metastasis and 1 had evidence of a liver mass and hemorrhagic peritoneal effusion. This may suggest that either the 2 dogs without histological confirmation had a primary tumor other than splenic hemangiosarcoma, or that even if these were misdiagnosed cases of hemangiosarcoma they represent a more indolent course than what has classically been understood for hemangiosarcoma. The other 2 dogs with evidence of presumptive or confirmed metastatic disease had survival times of 138 and 168 d. This is more consistent with previously reported median survival times for hemangiosarcoma. Contrast harmonic ultrasonography has been evaluated as a means to differentiate benign from malignant splenic disease and has failed to correlate with the eventual histologic diagnosis (14). Contrast harmonic ultrasonography has, however, proven useful in the differentiation of malignant versus benign hepatic masses (14,15).

The limitations of this study are that it was retrospective and that a single pathologist did not review the slides. Review of the slides may not have been helpful in determining if hemangiosarcoma cases had been misclassified as splenic hemATOMA cases, because in general, misclassification is more likely to be a factor of the portion of the mass selected in sampling and slide production, rather than incorrect interpretation of the diagnostic material available on the slide. Multiple recuts of the fixed specimen may be required in cases in which the clinical index of suspicion is that the case is of malignant splenic disease, but the material that is examined is consistent with hematoma. Additional recuts were not possible in this retrospective study because only the slides were available for review. It is unfortunate that post-mortem evaluation was not available for the 3 dogs that were euthanized as a result of suspected pulmonary or liver metastasis. Although it is possible that these events were unrelated, it is interesting that these 3 dogs died of suspected metastasis to sites that are commonly affected by splenic hemangiosarcoma.

One of the aims of this study was to determine factors that might raise the clinician’s index of suspicion that a case diagnosed with splenic hemATOMA is actually a malignancy such as hemangiosarcoma. A palpable mass during physical examination was a statistically significant negative prognostic factor with respect to survival and as such increases suspicion of a malignant process rather than a benign splenic hematoma. Sub-clinical coagulopathy and evidence of metastasis conferred a statistically significant protective effect with respect to survival. However, all 3 variables were only significant in univariate analysis. We did not determine any factors that were predictive for the development of metastatic disease. It is possible that we were not able to achieve this because, in our study, this only occurred in 4/35 (11%) of cases. With only 4 cases of presumptive or confirmed metastatic disease, our power was likely too low. No factors were significant prognostic factors in multivariate analysis. Cox proportional hazard modeling produced hazard ratios indicative of a protective effect of both the presence of metastatic disease and a coagulopathy. These results, obviously counterintuitive, are likely the result of low statistical power and it is likely that a greater sample number would dilute these results. Low statistical power was also the likely cause of the lack of statistical significance for the multivariate analyses performed in this current study.

In conclusion, the median survival time for canine splenic hemATOMA in this study was 674 d. This is longer than previously reported and indicates that in most cases, the long-term prognosis is excellent, even in breeds that are predisposed to splenic hemangiosarcoma. A small percentage of cases (11%) may in fact represent malignant disease. We were not able to identify any prognostic factors or factors that may predispose cases to metastatic disease in multivariate analysis in this study. Every histological diagnosis should be interpreted in light of all features of the case and more exhaustive sectioning and histological scrutiny may be warranted in certain cases but the criteria for this require additional studies.

References


Nick S. Rappa, Robert M. Radasch

Abstract — This study classified and determined the post-operative complication rate associated with stabilization of cranial (CCL) ligament deficient stifles in small- to medium-sized dogs with the Arthrex Canine Cranial Cruciate Ligament Repair Anchor System (CCLRAS). Eighty-five medical records from 2009 to 2012 from 1 institution were evaluated. Complications were classified according to previously proposed definitions for orthopedic studies in veterinary medicine. Fifty-two owners were contacted by telephone at least 6 months after surgery and given a questionnaire to classify complications related to the implant. A visual analog scale was used to assess functionality and degree of pain. The overall complication rate was 30.3% with an inflammation-infection rate of 5.4% and a documented infection rate requiring implant removal of 1.8%. Owners reported full or acceptable function in 96% of cases with an average functional score of 86.5. Stabilization of CCL-deficient stifles in small- to medium-sized dogs with the Arthrex Canine CCLRAS is reliable with acceptable complication rates.


Cette étude a classé et déterminé le taux de complications postopératoires associé à la stabilisation des grassets ayant un ligament croisé antérieur (LCA) déficient chez des chiens de petite à moyenne taille à l’aide du Système d’ancrage de réparation du ligament croisé antérieur Arthrex canin (SARLCA). Quatre-vingt-cinq dossiers médicaux datant de 2009 à 2012 qui provenaient de 1 institution ont été évalués. Les complications étaient classées selon des définitions proposées antérieurement pour des études orthopédiques en médecine vétérinaire. Cinquante-deux propriétaires ont été contactés par téléphone au moins 6 mois après la chirurgie et on les a interrogés afin de classer les complications relatives à l’implant. Une échelle analogue visuelle a été utilisée pour évaluer la fonctionnalité et le degré de douleur. Le taux global de complication a été de 30,3 % avec un taux d’inflammation-infection de 5,4 % et un taux d’infection documentée exigeant l’enlèvement de l’implant de 1,8 %. Les propriétaires ont signalé une fonction complète ou acceptable dans 96 % des cas avec une note fonctionnelle moyenne de 86,5. La stabilisation des grassets dont le LCA est déficient chez des chiens de petite à moyenne taille est fiable à l’aide du SARLCA Arthrex canin et comporte des taux de complications acceptables.

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Introduction

Multiple techniques and systems are available for neutralizing forces exerted on a cranial cruciate ligament (CCL) deficient stifle and it is a billion dollar industry (1). One technique is the lateral fabellar suture (LFS) that is a modification of the original procedure described by DeAngelis and Lau (2). Post-operative complications associated with the LFS technique are well-described (3). Complications include incisional issues, implant failure or pull through, infection, and nerve injury.

There are significant variations and adaptions of the LFS technique. More recently, emphasis has been placed on using isometric points to maximize stability and reduce implant failure when using extra-articular prosthetics (4). True isometry has not been achieved in any study; therefore, quasi-isometric points may be a more appropriate term. Quasi-isometry in the stifle joint uses attachment points in the femur and tibia that have minimal change in distance during flexion and extension. No clinical benefit has been documented when using quasi-isometric points in a CCL-deficient canine stifle. A retrospective article published in 2013 by Lodato et al (5) showed that FiberWire was 6 and 32 times more likely to fail compared to single and double stranded nylon leader line, respectively. This study used
FiberWire in a traditional LFS technique and the FiberWire failed by pulling through the femoral fabellar ligament. Arthrex has developed an implant using a titanium bone anchor and FiberWire that can be anchored in the quasi-isometric point of the femur and passed through a quasi-isometric bone tunnel in the tibia for reconstruction of cranial CCL-deficient stifles. Using quasi-isometric points in the canine stifle is theorized to minimize the elongation and stress on the extra articular implant. In addition to using the quasi-isometric points, the Arthrex CCL Repair System (CCLRAS) includes a femoral bone anchor to eliminate FiberWire pull through of the femoral fabellar ligament as a complication.

The goal of this study was to determine the post-operative complication rates and classify the complications associated with the Arthrex CCLRAS placed in the quasi-isometric points in a CCL-deficient stifle. We hypothesized that the Arthrex CCLRAS would have comparable post-operative complication rates to those of other techniques in CCL-deficient stifles in small- to medium-sized dogs.

Materials and methods

Case selection
Medical records of all dogs admitted to the Dallas Veterinary Surgical Center from September 2009 through December 2012 for CCL repair and treated with an Arthrex (Arthrex Vet Systems, Naples, Florida, USA) CCLRAS were reviewed. Only dogs that had surgery performed by 1 surgeon (RMR) were included to help control peri-operative variables and to eliminate surgeon experience variability. Dogs weighing less than 20 kg were offered this technique at the discretion of the surgeon. The diagnosis of CCLR was based on history, physical examination, and radiographs prior to intra-operative confirmation.

Surgical technique
All patients received peri-operative cefazolin (Cefazolin for Injection; Cefazolin Westward Pharmaceutical, Eatontown, New Jersey, USA), 22 mg/kg body weight (BW), IV that was repeated every 90 min as needed. Lateral approaches were made to the stifle and a limited medial arthrotomy was used to explore the stifle joint. Torn remnants of the CCL were removed. The menisci were probed and partial meniscectomy performed via sharp debridement if meniscal pathology was present. Normal menisci were left in place and not released. Placement of the Arthrex CCLRAS implant was performed with an open approach to the lateral stifle. Briefly, drawer motion was eliminated by placing an Arthrex titanium bone anchor in the quasi-isometric point in the distolateral femur approximately 3 mm distal to the articulation between the lateral femoral condyle and lateral fabella. A drill hole was made through the quasi-isometric point/the boney protuberance caudal to the long digital extensor tendon through the tibia exiting the proximal-medial surface of the tibia. The FiberWire was then passed through a titanium button on the medial surface of the tibia and passed back through the same bone tunnel and hand-tied on the lateral surface of the stifle joint in a normal standing angle with 6 half-hitch throws. Post-operative radiographs were obtained to confirm placement of the bone anchor and bone tunnel.

Post-operative care
Patients were placed in a soft-padded bandage overnight. All patients received 1 wk of cefpodoxime (Simplicef; Zoetis, Kalamazoo, Michigan, USA), 3 to 5 mg/kg BW, PO, a non-steroidal anti-inflammatory for 10 to 14 d and tramadol (Teva, Sellersville, Pennsylvania, USA), 2 to 5 mg/kg BW, PO for 10 d. The use of an Elizabethan collar was recommended for 10 to 14 d after surgery. Recheck examination with the surgeon was scheduled at 10 to 14 d and a follow-up examination at 4 to 6 wk after surgery. Limited activity was recommended for 8 to 10 wk.

Data collection
Age at surgery, breed, reproductive status, body weight, duration of anesthesia, intra-operative antibiotics, affected side, meniscal pathology, and post-operative antibiotics were recorded. Surgery time was not specifically recorded. Post-operative complications were evaluated using both medical records and telephone communication with the owners.

Definitions and criteria
Complications and functionality during the post-operative period were classified according to the proposed definitions and criteria published by Cook et al (6).

Time frame
• Peri-operative 0 to 3 months
• Short-term 3 to 6 months
• Mid-term 6 to 12 months
• Long-term >12 months

Subjective clinical outcomes on functionality
• Full function — normal level of duration and function of activities without medication
• Acceptable function — maintenance of intended activities to limited level and/or medication to achieve intended activities
• Unacceptable function — all other outcomes

Complications
• Catastrophic — resulting in death or is the cause for euthanasia
• Major — Requiring additional medications or surgery based on standard of care
• Minor — Not requiring additional surgery or medical treatment (minor incisional issues, bruising, seroma, minor lameness)

Functionality and long-term outcomes were also classified on a visual analog scale (VAS) (7). Functionality was judged on a scale of 0 to 100 with 100 representing pre-injury state or a complete return to normal function. Degree of pain was also evaluated on a VAS of 0 to 100 with 0 indicating no perceived pain and 100 indicating severe constant pain.

Owner communication
Owners were contacted via telephone to evaluate any potential complications and the time frame in which they occurred. Owners were also asked to determine functionality using 2 methods and to determine pain level. First, functionality was determined using a VAS. Second, owners were asked to subjectively classify function as full, acceptable or unacceptable. Lastly, owners were asked to rate level of pain on a VAS.
Table 1. Post-operative complications associated with Arthrex Canine Cranial Cruciate Ligament Repair Anchor System in small- to medium-sized dogs

<table>
<thead>
<tr>
<th>Complication</th>
<th>Weight (kg)</th>
<th>Meniscal pathology</th>
<th>Time of onset</th>
<th>Type</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>3</td>
<td>No</td>
<td>Peri-op</td>
<td>Incisional</td>
<td>E-collar</td>
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<tr>
<td></td>
<td>6.4</td>
<td>No</td>
<td>Peri-op</td>
<td>Lameness</td>
<td>Cage rest</td>
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<tr>
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<td>7.3</td>
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<td>Peri-op</td>
<td>Lameness</td>
<td>Cage rest</td>
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<tr>
<td></td>
<td>9.2</td>
<td>Yes</td>
<td>Peri-op</td>
<td>Incisional</td>
<td>E-collar</td>
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<tr>
<td></td>
<td>5.1</td>
<td>No</td>
<td>Peri-op</td>
<td>Lameness</td>
<td>Cage rest</td>
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<tr>
<td></td>
<td>6.5</td>
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<td>Incisional</td>
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</tr>
<tr>
<td></td>
<td>15.5</td>
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<td>Peri-op</td>
<td>Lameness</td>
<td>Cage rest</td>
</tr>
<tr>
<td></td>
<td>6.2</td>
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<td>Peri-op</td>
<td>Lameness</td>
<td>Cage rest</td>
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<tr>
<td></td>
<td>8.3</td>
<td>No</td>
<td>Long-term</td>
<td>Lameness</td>
<td>Cage rest</td>
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<tr>
<td>Major</td>
<td>8.1</td>
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<td>Short-term</td>
<td>Lameness</td>
<td>Analgesics</td>
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<td></td>
<td>12.6</td>
<td>No</td>
<td>Peri-op</td>
<td>Incisional discharge</td>
<td>Antibiotics</td>
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<tr>
<td></td>
<td>8.8</td>
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<td>Short-term</td>
<td>Incisional dehiscence</td>
<td>Antibiotics</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Yes</td>
<td>Peri-op</td>
<td>Broken FiberWire</td>
<td>Revision</td>
</tr>
<tr>
<td></td>
<td>7.7</td>
<td>Yes</td>
<td>Peri-op</td>
<td>Draining tract/infection</td>
<td>Explant</td>
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<tr>
<td></td>
<td>3.9</td>
<td>No</td>
<td>Peri-op</td>
<td>Consistent lameness</td>
<td>Revision</td>
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<tr>
<td></td>
<td>11.5</td>
<td>Yes</td>
<td>Short-term</td>
<td>Broken FiberWire</td>
<td>Revision</td>
</tr>
<tr>
<td>Catastrophic</td>
<td>6.6</td>
<td>Yes</td>
<td>Unknown</td>
<td>Unknown</td>
<td>Euthanasia</td>
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</table>

Peri-op = peri-operative.

Statistical analysis
Summary statistics were performed on the study population. A logistic regression analysis was conducted with complications (yes or no) as the outcome variable and covariates age, gender, weight, anesthesia time, side operated on, and meniscal pathology. Age, weight, and anesthesia time were modeled as continuous outcomes. Gender [intact female (F), intact male (M), spayed female (FS), and neutered male (MN)], side operated on (left or right), and meniscal tear (yes or no) were modeled as categorical outcomes. Odds ratios (OR) assuming a likelihood of no complication were calculated with 95% confidence intervals (CI) for each covariate.

Results
Epidemiologic data
Epidemiologic data were collected for 85 dogs. Average age at the time of surgery was 7.7 y (range: 1 to 14 y). Patients included 2 intact females, 51 spayed females, 32 neutered males, and no intact males. There were 32 breeds, the most highly represented being the Bichon Frise (9/85). Average weight of patients was 8.7 kg (range: 2.9 to 18 kg). Average anesthesia time was 1.4 h (range: 0.9 to 3.5 h).

Surgical procedures
Left CCLR was documented in 47/85 (55.2%) cases and right CCLR was done in 38/85 cases (44.8%). Meniscal pathology was noted in 45/85 cases (52.9%).

Complications
Long-term follow-up (> 6 mo post-surgery) was available for 54/85 (63.5%) dogs. Two owners could not be contacted via telephone but complications were documented in the record and were included for statistical analysis of complications. The cases analyzed for complications totaled 56 of the initial 85 cases.

Of the 56 cases analyzed for complications, 30.3% had complications. These complications were classified as minor in 52.9% (9/17), major in 41.1% (7/17), catastrophic in 5.8% (1/17) (Table 1). Of the 7 major complications, 4 required additional surgery. Of the 4 requiring additional surgery, 1 dog had an unstable stifle after surgery, 2 dogs had implant failures (FiberWire ruptured), and 1 had a documented implant infection via bacteriologic culture. The 3 dogs with major complications that did not require additional surgery were treated with oral medications, cage rest and/or an Elizabethan collar. The dog with the catastrophic complication was euthanized at an unknown point after surgery due to lack of mobility. The owners were unwilling to participate in the remainder of the survey.

As a result, the time frame for complications included 16/17 cases with reported complications. Of the 16 complications, 12 occurred in the perioperative period, 3 occurred during the short-term period and 1/16 was reported in the long-term period (Table 1).

Intact females were excluded from the logistic regression analysis because only 2 animals fell into this category. Breed was not included as a covariate given low replication within breeds. P-value associated with these covariates (age, gender, weight, anesthesia time, side and meniscal tear) were not statistically significant.

None of the odds ratios were significant; each 95% CI is found in Table 2. The low OR for gender (0.227) suggests the...
likelihood that no complications was lower in FS dogs compared with MN dogs. In FS dogs, the incidence of no complications was 63.2% (24/38) while in MN dogs, the incidence rate was 87.5% (14/16).

**Client-based assessments**

Client-based assessments and functional ratings were completed by 51 owners and partially completed by 1 owner. The mean function on the VAS reported by owners was 86.5. The mean score for pain on the VAS was 12.7. Owners reported full function in their dog in 65.3% of cases (34/52), acceptable function in 30.7% (16/52) of cases, and unacceptable function in 3.8% (2/52) of cases. One owner reported function as unacceptable but did not complete the entire survey. Overall, 96% of owners reported full or acceptable function.

**Discussion**

Complications of the LFS technique are well-documented. In a report published in 2009, Casale and McCarthy (3) documented complications in 63/363 surgical procedures (17.4%). In that study, complication rates for incisions and implants were 3.9% and 2.8%, respectively, based on lameness/swelling of the surgical site. A 2012 study that evaluated post-operative tibial plateau leveling osteotomy (TPLO) complications cited reported complication rates of 10% to 34% (8). Wolf et al (9) reported in 2012 that the complication rate for tibial tuberosity advancement (TTA) was 18.9%. The complication rate in the present study with the Arthrex Canine CCLRAS placed in quasi-isometric points for LFS stabilization was 30.3% (17/56).

Complications encountered herein were classified according to previously proposed definitions and criteria that may be used as a standardized system to define complications in orthopedic studies in veterinary medicine (6). Of the 17 complications encountered, 9 were minor and did not require additional medications or surgery. Five of the complications were minor lamenesses that resolved with 1 wk of cage rest and activity restriction. Four of these minor lamenesses occurred in the peri-operative period and 1 occurred in the long-term period. The remaining 4 minor complications were incision related and resolved with application of an Elizabethan collar for 1 week; all occurred in the peri-operative period (Table 1).

Seven major complications were encountered in this study: 4 required additional surgery, and 3 were treated with oral medication, cage rest, and/or application of an Elizabethan collar. One dog was treated with analgesics and cage rest for a lameness that occurred in the short-term period. Two dogs were treated empirically with oral antibiotics at the discretion of the surgeon without attempt to document an active infection. The dog of the first case had a minor incisional dehiscence secondary to licking that was treated conservatively with an additional week of cefpodoxime. The second dog had mild serosanguinous discharge from the distal incision in the peri-operative period after removal of the Elizabethan collar and licking the incision. The discharge resolved with an additional week of cefpodoxime. Clinically, these types of complications are encountered regularly and may be considered negligible by some. Classifying these aforementioned non-surgical complications as major increased the incidence of major complications in this study. However, the present study utilized previously proposed definitions in an effort to classify and standardize outcomes.

Four of 7 major complications required additional surgery. Implant failure occurred in 2 of these major complications and required surgical revision. Poor owner compliance and inappropriate activity restriction after surgery contributed to these failures. A third major complication requiring additional surgery was due to stifle laxity and lameness noted after surgery and was thought to be due to inappropriate implant placement. Two of these surgical revisions were treated with a TPLO and 1 was treated with a LFS following removal of the Arthrex CCLRAS. The fourth major complication requiring additional surgery was the only documented implant infection and occurred in a 12-year-old, spayed female poodle-mix dog. The dog presented in the peri-operative period with a draining tract at the incision. Radiographs showed periosteal changes around the proximal tibial bone tunnel and lucency around the bone anchor. The bone anchor and FiberWire were explanted and culture/sensitivity tests identified methicillin-resistant *Staphylococcus pseudointermidius*. The dog was treated with chloramphenicol for 4 wk and the infection resolved. The owner reported overall function as unacceptable with a functional score of 50 and pain score of 40. This dog did not have any further surgery to stabilize the stifle despite documented instability after surgery.

One dog had a catastrophic complication that resulted in death (euthanasia). The dog was a 4-year-old, FS, miniature poodle. The owners stated that the patient was euthanized due to lack of mobility and they were unwilling to provide additional information regarding the euthanasia. It was unclear when the dog was euthanized, if any diagnostics were performed, or whether the lack of mobility was directly related to the surgical repair of the CCLR or if it was due to some other disease (neurologic disease). Regardless, the case was included in the analysis of complications and resulted in a catastrophic complication rate of 1.8% (1/56).

Casale and McCarthy (3) reported a 17.4% complication rate in LFS with a documented infection rate of 3.9% confirmed by bacteriologic culture. Gallagher et al (10) reported a TPLO explant rate secondary to infection of 7.4%. The present study documented an explant rate and positive bacterial culture in 1.8% (1/56) of cases. The infection rates of the current study are lower than the reported infection rates of 2% to 2.5% for clean surgical procedures documented in a veterinary hospitals (11,12). The current study’s infection rate may actually be higher, as 2 dogs were treated empirically with oral antibiotics without bacteriologic culture at the discretion of the surgeon. Both dogs had complications classified as major that resulted from inflammation-infection of the incision due to licking and grooming. The inflammation that resulted was not directly related to the implant but it may have resulted in an implant infection if not treated promptly. Including the 2 inflammation-infection cases as infections, without bacteriologic culture, would raise the infection rate to 5.4% (3/56). Wolf et al (9) found an overall incisional inflammation-infection rate of 6.6% for the TTA procedure. In their study, medically treated
incisional complications represented 33.7% of all complications and were classified as minor; in our study, medically treated incisional complications were classified as major and represented 11.7% (2/17) of all complications. Our study utilized previously proposed definitions and criteria for orthopedic studies in veterinary medicine to allow direct comparison to future studies. Pacchiana et al (13) reported that post-operative infection rates after TPLO can be as high as 8.9%; however, not all infections were confirmed with culture. When only positive bacteriologic cultures were included, the infection rate was 3%. In 1981 Dulisch et al (14) reported a > 21% implant removal for infection in dogs after LFS; the high complication rate was reported to be largely due to the use of a multifilament non-absorbable suture that was used out of a cassette for stabilization of the stifle. Our study also evaluated a non-absorbable multifilament suture and revealed a 1.8% implant removal rate secondary to infection. The differences are thought to be largely due to advances in sterile and surgical techniques, peri-operative antibiotics, and post-operative antibiotic administration. Frey et al (15) suggested that the use of post-operative antibiotics lowers the risks of implant infection, whereas a recommendation from human literature suggests discontinuing prophylactic antibiotics 24 h after surgery for a clean procedure (16).

Consistent with previously reported rates, our study documented a 52.3% frequency of meniscal pathology at the time of surgery (17–19).

The visual analog scale is repeatable and valid for assessing lameness in dogs (7). The mean function score on the VAS in the current study was 86.5. The mean score for pain on the VAS was 12.7. A study in 2013 evaluated long-term outcomes associated with TPLO and TTA using the same VAS and showed a mean functional score of 93 for TPLO and 89.2 for TTA. Christopher et al (20) found that the owner function assessment for TPLO after surgery was full function in 76.9% of cases and acceptable function in 20% of cases, and for TTA was full function in 44.4% of cases and acceptable function in 44.5% of cases. In our study owners reported full function in 65.3% of cases and acceptable function in 30.7% of cases.

When analyzing complications we found no association with gender, age, weight, affected side, meniscal pathology, or surgical time, no significant association in any of the aforementioned categories, and no predisposing factors for reported complications.

Limitations, including those associated with the retrospective nature of the study, should be considered when interpreting results. Complications may have been addressed and treated by primary veterinarians rather than at our referral hospital. Variations in surgeon recommendation, experience, and surgical technique were limited in this study by using cases from 1 ACVS diplomate (RMR) for all surgeries. Not all owners could be contacted for assessments and responses. Another limitation is the small sample size. Furthermore, it is difficult to compare the current study to previous studies evaluating post-operative complications in CCL-deficient stifles because of variation in definitions and descriptions of complications. There is a need for standardization of outcomes. This study used previously proposed definitions of time frame, complications and outcomes for orthopedic studies in veterinary medicine for consistency and to allow direct comparison with future studies.

To our knowledge, this is the first study evaluating post-operative complications using the Arthrex CCLRAS placed in quasi-isometry for LFS stabilization of the CCL deficient stifle in dogs. Future, prospective randomized studies are suggested to compare this technique side-by-side with other repair techniques used in small- to medium-sized CCL deficient canine stifles.

This study showed that the Arthrex Canine CCLRAS for repair of CCLR in small- to medium-sized dogs has an overall complication rate of 30.3%; 52.9% of these complications were minor and treated without additional medication or surgery. The inflammation-infection rate was 5.4%; however, the documented post-operative infection rate that required implant removal was only 1.8%. The Arthrex Canine CCLRAS also provided full or acceptable function in 96% of cases with owners reporting an overall functional score on the VAS of 86.5.

References

Books Available for Review
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Abstract — This study evaluated the long-term prognosis of return to normal mechanical milking after reconstructive teat surgery and determined the factors that have an impact on the outcome. A retrospective study of 67 dairy cows with teat lacerations was performed. Milking status at discharge and at long-term follow-up was adequate for 83% and 75% of the cows, respectively. No statistically significant differences were detected between the long-term prognosis and the age of the cow, the stage of lactation at presentation, or the configuration of the laceration. Lacerations repaired more than 24 hours after the trauma were more frequently associated with a negative outcome (\(P = 0.05\)). Mastitis was the most frequent complication (\(n = 17\)) and had a statistically significant negative impact on long-term prognosis (\(P = 0.02\)). Reconstructive surgery of lacerated teat in dairy cows can help establish return to normal mechanical milking.

Résumé — Évaluation du pronostic à long terme en regard de la traite mécanique des trayons lacérés réparés chirurgicalement chez la vache : 67 cas (2003–2013). Les objectifs de cette étude sont d’évaluer le pronostic à long terme, en regard de la traite mécanique, suivant la reconstruction d’un trayon lacéré et de déterminer les critères associés à un pronostic négatif. Une étude rétrospective sur 67 vaches laitières a été réalisée. La traite mécanique était adéquate pour 83 et 75 % des vaches à leur sortie de l’hôpital et lors du suivi à long terme. Pas de différences statistiques ont été trouvées entre le pronostic à long terme et l’âge des vaches, leur stade de lactation et la configuration de la lacération. Les lacérations réparées plus de 24 heures après le trauma avaient un pronostic moins bon (\(P = 0.05\)). La complication la plus fréquente était la mammite (\(n = 17\)). Elle avait un effet négatif sur le pronostic à long terme (\(P = 0.02\)). Reconstituer chirurgicalement un trayon lacéré peut rétablir la traite mécanique.


Introduction

Teat lacerations are catastrophic injuries in dairy cattle. They are often self-inflicted when the cow stands, and can occur in tie stall or free stall barns. They have multiple configurations. If not repaired promptly, they can have serious consequences for the future of the animal. Mechanical milking of a lacerated teat is often impossible and the affected quarter becomes more susceptible to mastitis. Various surgical techniques have been described (1–4), with specific recommendations for the ideal suture material (5) and suture pattern (6–8).

Several authors have highlighted important prognostic indicators based on clinical impression. Early reconstruction seemed to be essential to achieve primary healing. Complex and transverse lacerations tend to have a poor prognosis since more blood vessels are severed compared to vertical lacerations. Finally, distal lacerations, in the proximity of or involving the streak canal, seemed to increase the risk of distal obstruction of the canal during the healing process (1–3). However, those prognostic indicators have never been validated. Therefore, the objectives of this study were to estimate the prognosis of return to normal mechanical milking after teat reconstructive surgery in dairy cattle and to determine the factors that have an impact on the prognosis. Our hypotheses are that the configuration, location, and delay between the laceration and the repair have an impact on long-term use of mechanical milking.
Materials and methods

Case presentation and laceration description

A medical record search was performed to identify cattle with teat lacerations that were presented to the veterinary teaching hospital between 2003 and 2013. Cows that had their teat amputated or that were not treated surgically were excluded. Data on age (older cow: ≥ 5 y old, younger cow: < 5 y old), breed and days in milk (0 to 30, > 30, dry period) of the cow were recorded. The quarter affected, the depth of the laceration (partial or full thickness), the shape (vertical, transverse or complex defined as laceration in more than one direction), the length of the laceration (< 3 cm or > 3 cm), location (proximal, mid, or distal), and the involvement of the streak canal were obtained from the record. The time between the trauma and the surgery (< 12 h, between 12 and 24 h and > 24 h) was retrieved. If the trauma was not seen, the delay was estimated based on the last time the owner saw the teat intact. For example, a teat intact at one milking but injured at the other was classified as a laceration > 12 h old. On a dry cow, if the injury was not seen, the laceration was classified as > 24 h old. The presence of clinical and subclinical mastitis [Black plate, California Mastitis Test (CMT) and culture results] prior to surgery or in the post-operative period was also surveyed.

Pre-operative treatments and surgical procedure

The pre-operative treatments, aseptic preparation, local anesthesia, and surgical technique were reviewed. The cows received pre-operative systemic antibiotics [procaine penicillin (Pen G; Vétoquinol, Lavaltrie, Quebec), 22 000 IU/kg body weight (BW), IM, or ampicillin (Ampicillin; Novopharm, Toronto, Ontario), 10 mg/kg BW, IV], non-steroidal anti-inflammatory drugs [flunixin meglumine (Flunazine; Vétoquinol), 1.1 mg/kg BW, IV, or ketoprofen (Anafen; Merial, Baie d’Urfé, Quebec), 3 mg/kg BW, IV], and light sedation [acepromazine (Atravet; Boehringer Ingelheim, Burlington, Ontario), 0.05 to 0.1 mg/kg BW, IM, or xylazine (Rompun; Bayer, Toronto, Ontario), 0.05 mg/kg BW, IV], prior to being placed in dorsal or lateral recumbency on a custom made tilt table. Chlorhexidine was used to clean the teat as well as for the surgical scrub. Prior to the surgical scrub, a ring block was performed at the base of the teat using 2% lidocaine. The lacerated teat was first meticulously debrided using a combination of irrigation or hydroulsion (18-gauge needle and 30 mL syringe) with sterile isotonic saline, and sharp dissection (#10 or #15 blade) to remove all embedded organic particles and necrotic tissue from the wound. Then, a 3-layer closure was performed (for full thickness laceration). The first layer included the mucosa and submucosa, which were sutured with 3-0 to 5-0 polyglycolic acid or polyglactin 910 with a simple continuous (vertical laceration) or simple interrupted (transverse laceration) pattern. In 1 cow (proximal and transverse laceration), the teat mucosa could not be apposed appropriately. A 12-mm (outer diameter) silicone implant was inserted in the teat and gland cistern to avoid adhesions and excessive granulation tissue formation at the surgery site. It was sutured in place with 3 simple interrupted sutures using polydioxanone (PDS; Guaynabo, Puerto-Rico). The second layer, consisting of the muscular and subcutaneous layers, was sutured with 3-0 to 5-0 polyglycolic acid or polyglactin 910 with a simple continuous (vertical laceration) or simple interrupted (transverse laceration) pattern. Finally, the skin was closed with 2-0 or 3-0 polybutester (Novafil; United States Surgical) with a simple interrupted, cruciate, or horizontal mattress suture pattern. Teat inserts or indwelling cannulas were used for distal lacerations. The teats were bandaged immediately after surgery while the cow was still on the table. The skin sutures were removed 10 d after the surgery.

Post-operative treatments and complications

The post-operative treatments were reviewed. Every cow received an intra-mammary infusion of antibiotics [Cefa Lak (Boehringer Ingelheim), Spectramast LC (Zoetis, Kirkland, Quebec), or 1 g cefazolin (Teva Canada, Toronto, Ontario) diluted in 20 mL of sterile water] after surgery. The intramammary antibiotic therapy was repeated if evidence of clinical mastitis was observed (swelling, pain, macroscopically modified milk on black plate). Post-operative systemic antibiotics were administered for at least 3 d.

A cow was considered to have a fistula if she had a small diameter hole along the suture line that leaked milk. Cows that had tearing of the suture material through the tissue exposing the teat cistern were considered to have dehiscence (partial or complete). Cows were assumed to have teat cistern fibrosis if the teat was firm on palpation and did not fill up with milk when the quarter was manually stimulated.

Outcome

The number of days before mechanical milking was resumed was documented. The status of mechanical milking at discharge was retrieved and qualified as adequate, difficult, or impossible. Difficult mechanical milking was defined as a quarter taking more than twice the time needed for the contralateral quarter to empty. Since a slow quarter is very frustrating for the owner, it was considered as a negative outcome in the statistical analysis. Through a standardized telephone interview with owners performed at least 6 mo after the surgery, the long-term prognosis regarding the possibility of performing mechanical milking on the affected quarter (adequate, difficult, and impossible) was recorded. Questions were also asked regarding healing of the teat, the presence of mastitis, the number of lactations completed since the surgery and the reason for culling. Finally, through the Canadian Dairy Network database, the number of lactations performed after the trauma by registered cows was retrieved.

Statistical analysis

The prevalence of front quarters versus rear quarters was compared using a Z-test. Univariable analyses were then performed using a Chi-square test to evaluate the different criteria (Table 1) associated with long-term prognosis. Univariable associations with a P-value ≤ 0.25 were retained for further modeling. Final
multivariable logistic regression models were built (GLIMMIX procedure in SAS) using backward elimination strategy until $P$-values of all remaining variables were $\leq 0.05$. Finally, the milking status at discharge was compared with the milking status at long-term follow-up using a concordance test ($k$). All the statistical analyses were performed using statistical computer software (SAS v.9.4; Cary, North Carolina, USA).

## Results

Sixty-seven medical records were reviewed. Sixty-three cows were Holstein, 3 were Ayrshire, and 1 was Jersey. The breed predisposition in this study represents the breeds of the farms surrounding the veterinary hospital. The mean age was 5.2 y (range: 2 to 12 y). After surgical reconstruction of the laceration, 83% (39/47), 8.5% (4/47), and 8.5% (4/47) of the cows had adequate, difficult, or impossible mechanical milking, respectively, at discharge from the hospital. Twenty cows were dry during their hospitalization or went home before being milked. At 6-month follow-up, 75% (46/61), 8% (5/61), and 17% (10/61) of the cows had adequate, difficult, or impossible mechanical milking, respectively, at the farm. Six cows were missing from the long-term follow-up because the owner could not remember the animal or retrieve their health record.

The milking status at discharge had a poor correlation with the milking status at the farm ($k = 0.07$). The status changed from adequate to difficult for 7 out of 39 cows (18%) and from difficult or impossible to adequate for 6 out of 18 cows (33%). Therefore, 28% (13/47) of cows had their milking status change between the time of discharge from the hospital and the long-term follow-up.

Fifty-seven percent (38/67) of the cows were older than 5 y. Fifty-one percent (27/53) of the cows were $< 30$ days in milk, 38% (20/53) were $> 30$ days in milk, and 11% (6/53) were in their dry period. No statistically significant difference was detected between the older ($\geq 5$ y) and the younger cows ($P = 0.25$), and between the days in milk (0 to 30, $> 30$, dry) ($P = 0.88$) in regards to long-term prognosis (Table 1).

Most of the owners did not witness the traumatic event. Sixty-six percent (44/67) of the lacerations involved the front quarter. The front quarter was more frequently involved than the rear quarter ($P = 0.01$). However, there were no statistically significant differences between the front and the rear quarter

### Table 1. Factors evaluated concerning long-term prognosis (mechanical status) of lacerated teat surgically repaired in 67 dairy cows in a referral center

<table>
<thead>
<tr>
<th>Factor</th>
<th>Definition (<em>n</em> available at follow-up)</th>
<th>Adequate (%)</th>
<th>Difficult or impossible (%)</th>
<th>$P$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>$&lt; 5$ y old ($n = 27$)</td>
<td>67</td>
<td>33</td>
<td>0.23</td>
</tr>
<tr>
<td></td>
<td>$\geq 5$ y old ($n = 34$)</td>
<td>82</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Stage of lactation</td>
<td>$&lt; 30$ d ($n = 25$)</td>
<td>72</td>
<td>28</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>$\geq 30$ d ($n = 18$)</td>
<td>78</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dry ($n = 4$)</td>
<td>75</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Quarter</td>
<td>Front ($n = 40$)</td>
<td>70</td>
<td>30</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>Rear ($n = 21$)</td>
<td>86</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Time of repair following trauma</td>
<td>$\leq 12$ h ($n = 35$)</td>
<td>80</td>
<td>20</td>
<td>0.05*</td>
</tr>
<tr>
<td></td>
<td>12 to 24 h ($n = 11$)</td>
<td>81</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\geq 24$ h ($n = 11$)</td>
<td>45</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>Depth</td>
<td>Partial ($n = 16$)</td>
<td>75</td>
<td>25</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Full ($n = 44$)</td>
<td>75</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Configuration</td>
<td>Vertical ($n = 7$)</td>
<td>86</td>
<td>14</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>Transverse ($n = 25$)</td>
<td>72</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Complex ($n = 28$)</td>
<td>75</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>$&lt; 3$ cm ($n = 13$)</td>
<td>69</td>
<td>31</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>$\geq 3$ cm ($n = 34$)</td>
<td>71</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Proximal ($n = 9$)</td>
<td>67</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mid ($n = 13$)</td>
<td>52</td>
<td>38</td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td>Distal ($n = 31$)</td>
<td>81</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Streak canal ($n = 9$)</td>
<td>78</td>
<td>22</td>
<td>1.00</td>
</tr>
<tr>
<td>Time of first mechanical milking after repair</td>
<td>$&lt; 5$ d ($n = 30$)</td>
<td>80</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\geq 5$ and $&lt; 10$ d ($n = 9$)</td>
<td>89</td>
<td>11</td>
<td>0.89</td>
</tr>
<tr>
<td></td>
<td>$\geq 10$ d ($n = 9$)</td>
<td>78</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Post-operative complications</td>
<td>Clinical mastitis ($n = 17$)</td>
<td>53</td>
<td>47</td>
<td>0.02*</td>
</tr>
<tr>
<td></td>
<td>Fistula ($n = 8$)</td>
<td>62</td>
<td>38</td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td>Dehiscence ($n = 4$)</td>
<td>50</td>
<td>50</td>
<td>0.25</td>
</tr>
</tbody>
</table>

* Statistically significant difference.
in regards to long-term prognosis ($P = 0.22$) (Table 1). Time between the traumatic event and the surgical repair was less than 12 h for 61% (37/61) of the cows, between 12 and 24 h for 19.5% (12/61) and $> 24$ h in 19.5% (12/61) of the cows. Lacerations older than 24 h had a statistically significant worse long-term prognosis ($P = 0.05$) (Table 1).

Seventy-three percent (48/66) of lacerations were full thickness; 11% (7/66) were vertical, 42% (28/66) were transverse, and 47% (31/66) were complex. There was no statistically significant difference regarding the depth or the shape of the laceration in regards to long-term prognosis ($P = 1.00$ and $P = 0.85$) (Table 1). Twenty-nine percent (15/52) of lacerations were $\leq 3$ cm in length, but this criterion made no statistically significant difference to the prognosis ($P = 1.00$) (Table 1).

Fifteen percent (9/58) of lacerations involved the proximal portion, 28% (16/58) involved the mid portion, and 57% (33/58) involved the distal end of the teat. The streak canal was involved in 30% (10/33) of distal lacerations. No significant differences in long-term prognosis were detected regarding the location of the laceration or the involvement of the streak canal ($P = 0.39$ and $P = 1.00$) (Table 1).

All lacerations were reconstructed upon admission. Eight surgeons were involved. Four of them had prior surgery-oriented residency training. No statistical difference, in regards to prognosis, was found between surgery trained and non-surgery trained surgeons ($P = 0.72$).

In 18 cows, a plastic (Indwelling milk tube; Mai, Elmwood, Wisconsin, USA) or a custom made silicone cannula was inserted through the streak canal and sutured to the teat skin to allow passive milking. Three had a laceration involving the streak canal, 4 the distal teat, 8 the mid-section and proximal teat and in 3 cases the localization was unknown. The cannula was left in place for 1 to 5 d and was removed before resuming mechanical milking. The other cows had their teat passively milked with a single use plastic cannula at milking. In the 12 cows in which the laceration involved the distal portion of the teat (6 streak canal and 6 distal teat), a silicone teat dilator (SIMPL; Jorvet, Loveland, Colorado, USA) was placed in the papillary duct for a variable period of time (1 to 10 d). Overall, 82% of the lacerations involving the streak canal, 45% involving the distal teat and 33% involving the mid and proximal teat, had a cannula or a teat dilator after the repair.

Mechanical milking was resumed within the first 5 d after surgery in 62% (30/48) of the cases, between 5 and 10 d in 19% (9/48) of the cases and $> 10$ d after the surgery in 19% (9/48) of the cases. No statistically significant difference was detected regarding the time of first mechanical milking and long-term prognosis ($P = 0.89$) (Table 1). Fifty percent of the cows with a transverse laceration were milked with the machine $> 5$ d after the surgery, whereas only 17% and 30% of the cows with vertical and complex lacerations, respectively, were milked $> 5$ d after the surgery.

The most frequent complications were clinical mastitis ($n = 17$), fistula ($n = 8$), partial dehiscence of the incision ($n = 4$), fibrosis of the teat ($n = 3$), and dripping between milking ($n = 3$). Five of the 17 cows with mastitis were infected

### Table 2. Pre-operative and post-operative factors associated with fistula, dehiscence, and fibrosis following repair of lacerated teats in a referral center

<table>
<thead>
<tr>
<th>Factor</th>
<th>Definition</th>
<th>Fistula ($n = 8$)</th>
<th>Dehiscence ($n = 4$)</th>
<th>Fibrosis ($n = 3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>$\leq 5$ y old</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>$\geq 5$ y old</td>
<td>6</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Stage of lactation</td>
<td>$\leq 30$ d</td>
<td>4</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>$\geq 30$ d</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Dry</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Quarter</td>
<td>Front</td>
<td>7</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Rear</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Time of repair following trauma</td>
<td>$\leq 12$ h</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>12 to 24 h</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>$\geq 24$ h</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Depth</td>
<td>Partial</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Full</td>
<td>7</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Configuration</td>
<td>Vertical</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Transverse</td>
<td>3</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Complex</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Length</td>
<td>$\leq 3$ cm</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>$\geq 3$ cm</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Location</td>
<td>Proximal</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Mid</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Distal</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Streak canal</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Time of first mechanical milking after repair</td>
<td>$&lt; 5$ d</td>
<td>6</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>$\geq 5$ and $&lt; 10$ d</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>$\geq 10$ d</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
before the surgical repair. The presence of post-operative clinical mastitis had a negative impact on the prognosis ($P = 0.02$) (Table 1). The microbial agents cultured were *Escherichia coli* ($n = 7$), *Staphylococcus aureus* ($n = 3$), *Pseudomonas aeruginosa* ($n = 2$), and 1 each of *Trueperella pyogenes*, *Streptococcus uberis*, *Streptococcus dysgalactiae*, *Klebsiella pneumoniae*, and yeast. Ease of milking of 6 *E. coli* and 2 *S. aureus* infected quarters was adequate at follow-up. Ease of milking of all the other infected quarters was not satisfactory.

Two of the 8 fistulas were closed surgically and were doing well at follow-up. There were problems with 3 of the remaining cows at follow-up: 2 were dripping milk and had chronic clinical mastitis and 1 had a fibrotic teat and quarter from acute mastitis. The other 3 cows were being milked satisfactorily even with the fistula. The presence of a fistula did not have a statistically significant impact on long-term prognosis ($P = 0.39$) (Table 1). Delay before repair ($\geq 24$ h) ($P = 0.01$) and the presence of post-operative clinical mastitis ($P = 0.02$) had an impact on the prevalence of fistula. The factors associated with fistulae are presented in Table 2.

Two of the 4 cows with a partial dehiscence were culled. The others were being milked satisfactorily at long-term follow-up. For those 2 cows, the dehiscence occurred during their hospitalization and was promptly repaired. Three cows with teat fibrosis were not being milked satisfactorily at follow-up. Two of them had post-operative clinical mastitis (*S. uberis* and *P. aeruginosa*).

In the multiple regression model, only the criterion “post-operative clinical mastitis” had a negative outcome at long-term follow-up ($P = 0.03$). The other criteria included in the model were age ($P = 0.06$) and time before repair ($P = 0.11$). Those criteria were chosen because they had the strongest impact (even if not statistically significant) on the prognosis in the univariate analysis.

It was possible to retrieve the milking records of 38 cows. Fifty-five percent (21/38) of them had at least 1 lactation following the trauma [median: 2 lactations (range: 1 to 4 lactations)]. Nineteen of those cows had a satisfactory milking status and 2 were difficult or impossible to milk at long-term follow-up. One of those 2 cows lost the operated quarter because of acute mastitis due to *E. coli*. She was kept as a 3-quarter cow and produced 12 555 kg of milk in 305 d. The other was kept although the affected quarter required a long time to be milked. She produced 10 015 kg of milk in 305 d.

Forty-five percent (17/38) of the cows did not complete their lactation or were culled at the end of their lactation. Seven of them were culled because the quarter was difficult or impossible to milk. Eight cows were culled with a functional quarter. Two of them had chronic mastitis in another quarter, 2 had udder suspensory ligament rupture, 1 had reproductive issues, and 4 were culled for unknown reasons unrelated to the surgery.

**Discussion**

Our primary objective was to evaluate the prognosis of return to normal mechanical milking of surgically repaired lacerated teat in dairy cattle. Our studies showed that 83% and 75% of repaired teats were being milked satisfactorily at discharge from the hospital and at long-term follow-up (> 6 mo after the surgery), respectively. However, a low kappa was obtained when a concordance test was performed to compare the mechanical status at discharge from the hospital with the status at follow-up. Therefore, the milking status at discharge did not ensure a similar status at the farm. Thirty-three percent of the quarters difficult to milk at discharge improved and 18% of the quarters that were milked satisfactorily at discharge became worse.

A second objective of our study was to determine the factors that had a significant impact on long-term prognosis. Factors such as configuration (transverse or complex), location (distal), or delayed repair have always been thought to have a negative impact on the prognosis. In our study, we were able to show that the time of repair after the trauma had an impact on mechanical milking. Lacerations repaired more than 24 h after the trauma were more likely to cause impossible milking of the quarter at long-term follow-up. Since the other factors did not have a significant impact on long-term prognosis, we had to partially reject our hypothesis. An interesting but not surprising finding was that the presence of post-operative clinical mastitis had a significant negative impact on the milking status at long-term follow-up.

Surgical site infection, in any tissue, has serious consequences on healing (9,10). Infection delays healing and can precipitate resorption of suture material, leading to total or partial dehiscence of the surgery site (5,11). In teat surgery, no study has looked at the effect of clinical mastitis on the healing of a thelotomy or a repaired laceration. Our clinical experience tells us that exuberant granulation tissue and adhesions frequently formed along the mucosa in face of clinical mastitis. Depending on the location or the size of the laceration, this tissue may or may not have an impact on milk flow. In our study, 2 cows with partial dehiscence of their repair had clinical mastitis. Five of the 8 cows that developed a fistula also had clinical mastitis. No bacterial cultures were performed on the incisions. However, it is highly suspected that they were infected which led to further complications. It is therefore important to diagnose clinical mastitis early by performing black plate analysis at every milking and doing bacteriological culture on positive results. These test results will allow prompt treatment of affected quarters with the appropriate medications. If pre-operative clinical mastitis is identified, using a suture material that retains its strength for a longer period of time might be indicated (5).

In our study, many microbial agents were isolated, with the main agents being *E. coli* and *S. aureus*. Interestingly, those 2 agents rarely caused complications at long-term follow-up compared with the other agents isolated such as *T. pyogenes* and *P. aeruginosa*. It is possible that early aggressive treatment (intra-venous fluids, intra-mammary antibiotics, non-steroidal anti-inflammatory drugs, and systemic antibiotics) combined with an *E. coli* lacking virulence factors (not evaluated in this study) were responsible for the lack of long-term negative effect on the teat. For *S. aureus*, it is possible that the intramammary antibiotic given was able to locally control the infection in the early phase of healing of the teat. In summary, it seemed that we were able to achieve clinical healing, not necessarily bacteriological healing, of clinical mastitis caused by *E. coli* and *S. aureus*, therefore, preventing further complications during the healing.
of the laceration. However, it seemed that we were not able to achieve the same results when _T. pyogenes_ and _P. aeruginosa_ were involved, explaining the higher rate of fistula and dehiscence when those 2 agents were isolated.

Repairing lacerations less than 24 h after the trauma did not have a negative impact on the long-term outcome. However, when the repair was delayed for more than 24 h, mechanical milking at long-term follow-up was more likely to be compromised. Similarly, a fistula along the laceration repair was more likely to be present. These results are in agreement with the study by Azizzi et al. (12) that showed that lacerations more than 24 h old were more at risk of developing a fistula. However, even if the prognosis is poor when the repair is delayed (45%), we believe the surgery should still be performed. It is easier to repair a fistula or a partially dehisced incision than to reconstruct a scarred and fibrotic teat cistern. As with quarters with clinical mastitis, a suture material retaining its strength for a longer period of time might be indicated for delayed repair attempt.

The configuration and location of the laceration had no impact on the prognosis. Seventy-two percent of quarters with transverse lacerations had adequate milk flow at follow-up. This type of laceration was thought to carry a poor prognosis since it compromises the vasculature more than vertical lacerations (1–3). Careful debridement and reconstruction combined with an extended rest from mechanical milking (50% were milked (1–3). Careful debridement and reconstruction combined with an extended rest from mechanical milking (50% were milked with the machine more than 5 d after the surgery) were probably key elements for a successful outcome. Even the cow that required a silicone prosthesis had successful healing and return to mechanical milking. However, because of the high morbidity rate associated with this implant, it should only be used when primary closure of the mucosa is not possible (13–18).

Distal lacerations or lacerations involving the streak canal were also thought to carry a poor long-term prognosis (1–3). These types of lacerations, because of the proximity or the involvement of the streak canal, are more susceptible to adhesions that could completely or partially obstruct milk flow. In our study, 80% of cows with a laceration involving the streak canal and/or the distal end of the teat had satisfactory milk flow at long-term follow-up. Eighty-two percent of teats had a cannula or a teat dilator used during the postoperative period compared to only 33% of cows with a mid or a proximal teat lesion. This type of plug has been used to treat internal lesions. This type of plug has been used to treat internal lesions. A plug has been used to treat internal lesions. A plug has been used to treat internal lesions.

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The only similar study published on teat lacerations found that older cows had more lacerations than younger cows and were more susceptible to post-operative complications such as fistula (12). The researchers found that lacerations occurred more frequently in the first month of lactation and that the front quarters were more frequently involved. The most frequent configurations were vertical since the lacerations occurred on pasture on barbed wire. In our study, the only similarities were the more frequent involvement of the front quarter and the stage of lactation when the laceration occurred. Age had no impact on the healing and older cows were not overrepresented. The most frequent configurations were transverse and complex. This difference could be explained by the different dairy cattle husbandry practices between our 2 countries. In North America, dairy cattle are mostly kept in tie stalls or in free stalls. Lacerations are self-inflicted (dew claws) or caused by a neighboring cow resulting in transverse and complex lacerations.

Our study involved a large number of cows with teat laceration. Like most retrospective studies, not all the needed information could be retrieved from the medical records or milking database thereby decreasing the power of our analysis. However, we were able to identify that delayed repair and post-operative clinical mastitis had a statistically significant negative impact on long-term prognosis and on the incidence of teat fistula. In face of clinical mastitis, the owner should be warned that the prognosis to re-establish mechanical milking from the injured teat is poor. An informed decision can then be taken, depending on the value of the animal, to pursue further treatment on the teat.

In conclusion, all types of lacerations can heal and allow mechanical milking with thorough debridement and careful reconstruction. Teat lacerations are emergencies and should be repaired as soon as possible. Clinical mastitis should be treated aggressively and clients should be warned of the risk of dehiscence and possible fistula formation. Finally, it is important to note that the mechanical milking status can change in the weeks following the repair. Therefore, a teat difficult to milk early after the repair should be given time to heal before being declared a failure.

**Acknowledgments**

The authors acknowledge Dr. Nicolas Tyson and Mme Josée Lemaury-Courchesne for building the database, M. Guy Beauchamp for the statistical analysis and Dre Marketa Kopal for her linguistic help.

**References**


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*Association between thermal environment and Salmonella in fecal samples from dairy cattle in midwestern United States* on page 183

*Relationship of skeletal muscle inflammation with obesity and obesity-associated hyperinsulinemia in horses* on page 217

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*Association between thermal environment and Salmonella in fecal samples from dairy cattle in midwestern United States* à la page 183

*Relationship of skeletal muscle inflammation with obesity and obesity-associated hyperinsulinemia in horses* à la page 217

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Case Report  Rapport de cas

A cluster of trace-concentration methamphetamine identifications in racehorses associated with a methamphetamine-contaminated horse trailer: A report and analysis

Kimberly Brewer, Theodore F. Shults, Jacob Machin, Sucheta Kudrimoti, Rodney L. Eisenberg, Petra Hartman, Caroline Wang, Clara Fenger, Pierre Beaumier, Thomas Tobin

Abstract — Three low concentration methamphetamine “positive” tests were linked to use of a methamphetamine-contaminated trailer to transport the affected horses. This incident establishes methamphetamine as a human-use substance that can inadvertently enter the environment of racing horses, resulting in urinary methamphetamine “positives;” an interim regulatory cut-off of 15 ng/mL for methamphetamine in post-race urine is proposed.

Résumé — Identifications de concentrations de méthamphétamine à l’état de traces chez des chevaux de course associées à une remorque contaminée : rapport et analyse. Trois tests «positifs» de faibles concentrations de méthamphétamine ont été associés à l’utilisation d’une remorque contaminée par les méthamphétamines qui était utilisée pour transporter les chevaux affectés. Cet incident établit la méthamphétamine comme une substance à utilisation humaine qui peut pénétrer par inadvertance dans le milieu des chevaux de course, entaïnent ainsi des tests d’urine «positifs»; un niveau intérimaire réglementaire de 15 ng/mL pour les méthamphétamines est proposé pour les tests d’urine après la course.

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Introduction

Methamphetamine (N-methyl-1-phenylpropan-2-amine, C_{10}H_{15}N, molecular mass 149.2) is a phenylethylamine central nervous system stimulant and a Schedule I controlled substance in Canada. Methamphetamine exists as 2 enantiomers, \(d\)-methamphetamine and \(l\)-methamphetamine (Figure 1). \(d\)-methamphetamine is the more pharmacologically active enantiomer and is a DEA Schedule II controlled substance in the United States. In the US, \(d\)-methamphetamine is FDA approved for human use and is available as Desoxyn for the treatment of Attention Deficit Hyperactivity Disorder (ADHD) and other conditions. \(l\)-methamphetamine is available in the US in “over-the-counter” decongestant products such as Vicks VapoInhaler, in which the \(l\)-methamphetamine is identified as “levetamfetamine.”

Racing laboratories now use Liquid Chromatography-Tandem Mass Spectrometry (LC/MS/MS) to test for methamphetamine. This has led to more than a thousand-fold increase in the sensitivity of testing compared with traditional enzyme-linked immunosorbent assay (ELISA) testing and the identification of trace level concentrations of substances (such as methamphetamine) that would not previously have been identified. While these trace level identifications are pharmacologically insignificant, they may be reported as “positives” under “zero tolerance” regulatory guidelines required of racing chemists.

Methamphetamine is also illegally synthesized and may be widely available as a “street” drug of uncertain purity and enantiomeric (\(d/l\)) composition. The drug is produced in illicit synthesis laboratories that are kept undercover, and a large horse trailer would be well-suited to a mobile covert laboratory.

We now report an incident in which a recently purchased horse trailer contaminated with methamphetamine yielded a cluster of 3 trace-concentration post-race urinary methamphetamine identifications within a 48-hour period. The trainer’s only other horse was transported in a different trailer and tested negative.

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The contaminated trailer was purchased by the horse trainer a few days prior to using it to ship horses on October 12th from Michigan to the 2014 Ajax Downs Quarter Horse Racing meet in Toronto. First contact of the affected horses with the methamphetamine-contaminated trailer was when they were loaded into the trailer for transportation to Toronto. The journey took 6 h, following which the horses were stabled in the Toronto area and transported to race at Ajax Downs on October 13th and 14th. The 3 horses that were transported in the newly purchased trailer raced successfully and were post-race tested, 2 on October 13 and 1 on October 14 (Table 1). Horse #1 won a maiden race on October 13th and tested positive for methamphetamine at 0.2 ng/mL. Horse #2 ran second on October 13th and tested positive at 0.056 ng/mL. Horse #3 won a starter allowance on October 14th and tested positive at 0.34 ng/mL. Horse #4 was transported from Michigan to Toronto in a different trailer. This horse raced and was tested on October 13th and did not test positive for methamphetamine or any other substance.

The samples were called methamphetamine “positive” in post-race urine tests performed by the official Canadian Laboratory, Maxxam Analytics of Burnaby, British Columbia. The referee split sample analyses were performed by Industrial Laboratories, Denver, Colorado, which confirmed the identifications and quantified the amounts present. The analytical methodologies available at that time in either laboratory did not distinguish between the d- and l-enantiomers of methamphetamine; however, more recent work at Industrial Laboratories has confirmed that the methamphetamine was present predominantly as the d form. No information is available concerning the presence of metabolites of methamphetamine — principally amphetamine — presumably because such information was not required and/or requested.

Laboratory testing for methamphetamine

In the United States, federal workplace testing identification of 80% or more l-methamphetamine suggests over-the-counter drug use, versus lower levels, which suggests illicit drug use (1,2). Also, the United States federal workplace testing protocol of the Substance Abuse and Mental Health Services Administration (SAMHSA) requires that methamphetamine/amphetamine be present in urine at >500 ng/mL by immunological testing and that methamphetamine be confirmed by mass spectrometry at >250 ng/mL, followed by confirmation of the metabolite, amphetamine, at a concentration >100 ng/mL before a positive methamphetamine report may be issued (3).

This compares to the cut-offs suggested in “The Canadian Model for Providing a Safe Workplace: Drug and Alcohol Guidelines and Work Rule v5.0” of 500 ng/mL for total amphetamines (including d-/l-methamphetamine), with verification via GC-MS having a cut-off of 250 ng/mL for specific compounds (4). While these suggested levels are cutoffs recommended by a professional organization of construction workers, their levels seem to match SAMHSA, and indicate similar levels are likely in Canada.

Scientific literature yields numerous reports showing that methamphetamine persists in the environment and in wastewater (5,6). These findings speak to inconsequential levels associated with both licit and illicit human use in the environment, and also demonstrate its ability to persist in the environment (6,7), consistent with the presence in the contaminated trailer in the current matter.

The close spatial and temporal clustering of these 3 trace-concentration, methamphetamine identifications is an extremely unusual event, both in the long time professional experience of the involved trainer, and in the scope of the human and equine drug testing experience of the authors. In particular, the trainer in question in this matter was in good standing with the Ontario Racing Commission (ORC). Furthermore, it is also extremely unusual to see 3 very low/trace concentration ARCI class 1 substance identifications occurring in a small group of horses within a 48-hour period.

The ORC personnel investigating this matter also recognized the unusual nature of this cluster of methamphetamine identifications. Following a series of interviews with the trainer and her staff, and considering the overall circumstances of this matter, the ORC investigators elected to take a number of samples from the trailer in which the horses in question were transported from Michigan to Toronto for methamphetamine testing, with a particular focus on the manger areas of the trailer.

Analysis of these trailer samples showed that at least 1 of these samples taken from the manger area of the trailer tested positive for methamphetamine at a concentration of 22 ng/g, or 22 parts per billion. This positive finding for methamphetamine...
in the trailer is entirely consistent with the underlying cause of this cluster of trace urinary concentration methamphetamine identifications being this trailer's contamination by methamphetamine, since the horses spent 6 h in the contaminated trailer during their journey from Michigan to Toronto while being shipped to Ajax Downs.

These interpretations were also recognized by the lead ORC investigator, who testified at the Stewards hearing that the methamphetamine identifications were apparently the result of inadvertent exposure of the horses to the contaminated trailer and that the identifications did not in any way reflect on the trainer involved.

The scientific literature on methamphetamine in the horse supports the ORC investigators analysis and interpretations. Work by Ray et al (8) shows that after IM administration of 150 mg methamphetamine to horses the urinary concentrations of methamphetamine peak at a mean of about 7400 ng/mL (range: 3240 to 17 930 ng/mL) at 4 h post-administration and thereafter decline. The urinary concentrations of methamphetamine reported in the current matter are between 20 000 and 130 000 times lower (0.34 and 0.056 ng/mL samples, respectively) than the mean peak urinary concentration reported by Ray et al (8) after their methamphetamine administrations.

A second conclusion that may be drawn from the trace concentrations of methamphetamine observed in these samples is that the amounts of methamphetamine present in the urine samples of these animals are 10^5 of the concentration which would be consistent with production of a pharmacological effect (8). As such, it is a reasonable conclusion that there was no effect on the racing performance of the horses in question.

The identification of trace level concentrations of human-use substances in the post-race urine samples of racing horses is a not an uncommon occurrence. Beginning in the 1990s, the ongoing increases in the sensitivity of drug and medication testing in racehorses has created a need to develop regulatory thresholds/cut-offs for Endogenous, Dietary and Environmental substances (EDEs) in post-race urine samples (2,9).

Establishing regulatory cut-offs (thresholds)

The first trace environmental substance to come to the attention of racing regulators was caffeine, and Florida racing regulators introduced a plasma regulatory threshold of 100 ng/mL, a cut-off since adopted by the Association of Racing Commissioners International (ARCI) and now in place in at least 10 US jurisdictions. In Florida, this threshold has since been adjusted to 200 ng/mL in urine (10).

Another environmental substance regulatory cut-off used in several states is for benzoylecgonine (BZE), the major urinary metabolite of cocaine, which is efficiently excreted at relatively high concentrations in equine urine. Like caffeine, cocaine is widespread in the human environment and is found in measurable quantities on about 80% of paper money in the US. Though exposure to the quantity of cocaine on paper money is generally insufficient to produce a pharmacological effect, ingestion by a horse of an amount of cocaine not uncommonly found on a single dollar bill in general circulation can produce a measurable concentration of BZE in the horse's urine — a potential positive test (11).

One outcome of the widespread environmental presence of trace amounts of cocaine is that US Department of Health and Human Services human workplace drug testing has a BZE urinary screening “cut-off” of 150 ng/mL and a confirmation cut-off of 100 ng/mL (12). This threshold was essentially adopted by a number of racing commissions, and equine urinary BZE thresholds are in place in at least 7 US racing jurisdictions ranging from 50 to 150 ng/mL (2,11).

Morphine is also an ARCI class 1 substance that is occasionally identified in post-race equine urine samples, usually as classic clusters associated with inadvertent feed contamination, although isolated cases occur in which the source of the morphine remains unidentified. Again, the solution to this problem has been the introduction of equine urinary cut-offs varying from 50 to 120 ng/mL depending on the jurisdiction involved (2,12,13). These equine urinary cut-offs are considerably more rigorous than the 2000 ng/mL opiate cut-off used in US Department of Health and Human Services human workplace drug testing (3).

Consistent with the above referenced well-established regulatory cut-offs for environmental substances, it is now apparent that the increased sensitivity of testing for methamphetamine has created a need for its own regulatory cut-off in equine testing. In the absence of a defined regulatory cut-off, “positives” are reported down to the limit of detection of the analytical method. The sensitivity of testing for methamphetamine in this current matter, at a limit of detection of about 0.05 ng/mL (50 pg/mL), is 1000 times less concentrated than the cut-offs for caffeine, benzoylecgonine, and morphine in post-race urine samples, and 10 000 times less than the 500 ng/mLamphetamine screening human cut-off of the US Department of Health

<table>
<thead>
<tr>
<th>Horse</th>
<th>Race date (2014)</th>
<th>Race type</th>
<th>Race result</th>
<th>Trailer</th>
<th>Time in trailer A (hours)</th>
<th>Sample (Maxxam lab test result)</th>
<th>Split sample (Industrial lab test result)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fames Winner</td>
<td>Oct 13</td>
<td>Maiden</td>
<td>Win</td>
<td>A</td>
<td>6+</td>
<td>Positive</td>
<td>0.20 ng/mL</td>
</tr>
<tr>
<td>Chasing Royalty</td>
<td>Oct 13</td>
<td>Allowance</td>
<td>Place</td>
<td>A</td>
<td>6+</td>
<td>Positive</td>
<td>0.056 ng/mL</td>
</tr>
<tr>
<td>JJ Maxwell</td>
<td>Oct 14</td>
<td>Starter Allowance</td>
<td>Win</td>
<td>A</td>
<td>6+</td>
<td>Positive</td>
<td>0.34 ng/mL</td>
</tr>
<tr>
<td>Jess What To Wear</td>
<td>Oct 13</td>
<td>Allowance — non winner of two</td>
<td>Win</td>
<td>B</td>
<td>0</td>
<td>Negative</td>
<td>N/A</td>
</tr>
</tbody>
</table>

The Maxxam laboratory and Industrial laboratories tested split samples. N/A — Not available.

Table 1. Transportation, racing and urinary methamphetamine analytical data on 4 horses transported to Ajax Downs, Toronto, Ontario, for racing on October 13 and 14, 2014.
and Human Services (3). The only question that remains is to determine precisely what the appropriate concentration for this urinary methamphetamine cut-off should be. Review of data generated by Ray et al (8), which showed a mean peak urinary concentration of methamphetamine of 7400 ng/mL following administration of a 150 mg dose of methamphetamine, suggests that a 1000-fold lower urinary methamphetamine concentration, as seen in the cluster of horses in question, is unlikely to be associated with a pharmacological effect. Therefore, a urinary methamphetamine concentration of < 15 ng/mL in urine would be unlikely to be associated with any possible effect on a horse at the time of racing, and as such would be an appropriate interim environmental cut-off for methamphetamine identifications in post-race urines.

With respect to developing an environmental substance threshold or cut-off for methamphetamine in post-race urine samples, it may be instructive to consider the protocol used in US Department of Health and Human Services human workplace drug testing for methamphetamine. To report a urine sample positive for methamphetamine the sample must first yield an initial immunoassay result of more than 500 ng/mL for combined amphetamine/methamphetamine reactivity, then the laboratory must confirm by Mass Spectrometry that the sample contains more than 250 ng/mL of methamphetamine and also that the sample contains at least 100 ng/mL of the metabolite, amphetamine. This is to show that the methamphetamine has actually passed through the individual in question. This precaution is required as early GC/MS confirmation procedures used in human drug testing were shown to convert ephedrine to methamphetamine and it was necessary to rule out analytical neogenesis of methamphetamine from ephedrine.

It is well-established that individuals living in or exposed to clandestine methamphetamine laboratories become contaminated with methamphetamine and will test positive for methamphetamine at much higher concentrations than is required for human workplace positive identifications. These positives occur not because they are actively using the drug, but simply from environmental exposure; this is best seen with regard to toxicology studies on children and infants found living in places where methamphetamine is being manufactured, according to a Department of Justice review (14). With regard to the difficulty of removing methamphetamine residues from such an environment, this report notes that "Normal cleaning will not remove methamphetamine and some of the chemicals used to produce it. They may remain on eating and cooking utensils, floors, countertops, and absorbent materials. Toxic by-products of meth manufacturing are often improperly disposed outdoors, endangering children and others who live, eat, play, or walk at or near the site." (14). One author (TFS) has recommended that first-responders and police officers be screened both before and after their exposure to drug laboratories or drug storage facilities.

Methamphetamine, a substance of human use/abuse, can inadvertently become part of the environment of racing horses, yielding trace urinary methamphetamine “positives” in post-race testing. As such, there is a need to establish a cut-off or threshold for methamphetamine in equine drug testing, as has been done for other environmental substances (caffeine, BZE, morphine, etc.) to avoid unjustly penalizing the connections of the horse and tarnishing the image of racing. We therefore suggest an interim urinary threshold/cut-off for methamphetamine of at least 15 ng/mL, similar to thresholds already established for other environmental substances, and well below the 500 ng/mL cut-off used by the US Department of Health and Human Services in human workplace drug testing. This interim threshold would be appropriate prima facie until a review leads to a formal regulatory decision to establish a threshold that takes into account metabolite concentrations and effects of other variables, such as urine pH, on racehorse sample concentrations. While it may need to be raised or lowered in the future, 15 ng/mL is at this time a conservative estimate based upon the current findings in the case presented.

Acknowledgments

Published as paper #424 from the Equine Pharmacology, Therapeutics and Toxicology Program at the Maxwell H. Gluck Equine Research Center and Department of Veterinary Science, University of Kentucky. The information reported in this paper is part of a project of the Kentucky Agricultural Experiment Station (KAES publication #15-14-057) and is published with the approval of the Director. This research was supported by grants from the USDA Agriculture Research Service Specific Cooperative Agreement #58-6401-2-0025 for Forage-Animal Production Research, the Kentucky Department of Agriculture, and the Kentucky Thoroughbred Association Foundation and by support for the Kentucky Agricultural Experiment Station as provided by the National Institute of Food and Agriculture (NIFA) and the Commonwealth of Kentucky. Other support that made this work possible includes research support from The National Horsemen’s Benevolent and Protective Association and the Alabama, Arizona, Arkansas, Ontario, Canada; Charles Town, WV; Florida, Indiana, Iowa, Kentucky, Louisiana, Michigan, Minnesota, Nebraska, Ohio, Oklahoma, Oregon, Pennsylvania, Tampa Bay Downs, Florida, Texas, Washington State, and West Virginia Horsemen’s Benevolent and Protective Associations, and Mrs. John Hay Whitney.

Note

In Ontario, these matters went to a Steward’s hearing on October 23rd, 2014; despite the weight of evidence for trainer innocence, the trainer was fined $5000 and suspended for 1 year. The matter was appealed to the Ontario Racing Commission (ORC), which held hearings related to this matter in July to September 2015. On February 8th, 2016 the ORC allowed the appeals and set aside the Steward’s penalties. The ORC noted the substantial increases in sensitivity of equine drug testing, consistent with the very low levels of methamphetamine identified in these horse urines, levels in the opinion of the ORC with no possible impact on the performance, health and safety of horses, and levels consistent with inadvertent environmental contamination. The ORC also noted the need “to set limits high enough to cut-off the environmental noise and low enough to stop performance enhancement.” In this communication we have presented our best estimate of this as 15 ng/mL interim regulatory cut-off for methamphetamine in post-race horse urine.

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References
Case Report Rapport de cas

A case of factor X deficiency in a Chihuahua dog
Jessica Heuss, Linda Weatherton

Abstract — A juvenile Chihuahua dog developed hemoperitoneum after routine ovariohysterectomy. She was managed with packed red blood cell and fresh frozen plasma transfusions as well as an exploratory laparotomy to verify ligature sites. No recurrence of hemorrhage occurred. Factor X deficiency was diagnosed and confirmed with repeat analysis including during times of health.

Résumé — Cas de carence du facteur X chez une chienne Chihuahua. Une jeune chienne Chihuahua a développé un hémopéritoine après une ovariohysterectomie de routine. Elle a été gérée à l’aide de concentrés de globules rouges et de transfusions de plasma frais congelé ainsi que d’une laparotomie exploratoire pour vérifier les sites de ligature. Aucune récurrence d’hémorragie ne s’est produite. La carence du facteur X a été diagnostiquée et confirmée par une analyse répétée durant des périodes de santé.

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Factor X deficiency is a rare bleeding disorder in humans, the incidence of which is approximately 1:500 000 to 1:1 000 000 (1–3). The incidence of this disease is unknown in veterinary medicine; however, it is thought to be rare (4). The heterozygous incidence may be as high as 1:500 with many dogs being asymptomatic. No humans with deletions of both factor X genes have been reported, indicating that complete deficiency of factor X is incompatible with life (5). To the authors’ knowledge, this is the first Chihuahua dog diagnosed with factor X deficiency (6,7). Repeated diminished activity of factor X, even during times of health, indicates the hemorrhagic event reported was secondary to congenital factor X deficiency.

Case description

A 7-month-old, 3.5 kg, spayed female Chihuahua dog was referred with a hemoperitoneum 5 d following routine ovariohysterectomy. She had initially recovered well but had become lethargic and anorexic over the preceding 24 h. She was receiving Tramadol (Teva, Sellersville, Pennsylvania, USA), 12.5 mg PO, q12h, for pain control. She was presented to her primary care veterinarian whose laboratory analysis revealed the following: elevated blood urea nitrogen [BUN; 13.9 mmol/L; reference interval (RI): 2.5 to 8.9 mmol/L], hypoproteinemia (38 g/L; RI: 54 to 82 g/L), and hypoglobulinemia (11 g/L; RI: 23 to 52 g/L). A complete blood (cell) count (CBC) revealed anemia [red blood cells (RBC) 1.71 \( \times \) 10\(^{12}\)/L; (RI: 5.5 to 8.5 \( \times \) 10\(^{12}\)/L), hemoglobin 33 g/L; (RI: 120 to 180 g/L), hematocrit 0.11 L/L; (RI: 0.37 to 0.55 L/L), thrombocytopenia (18 \( \times \) 10\(^9\)/L; RI: 200 000 to 110 000/\( \mu \)L) and leukocytosis [white blood cells (WBC) 22.87 \( \times \) 10\(^9\)/L; RI: 6 to 17 \( \times \) 10\(^9\)/L]. Abdominal radiographs revealed diminished serosal detail and a point-of-care abdominal ultrasound revealed peritoneal fluid. Abdominocentesis revealed non-clotting blood.

Upon presentation the patient was recumbent with pale mucous membranes, tachycardia [200 beats/min (bpm)], tachypnea (40 breaths/min) and hypothermia (36.4°C). The dog had a grade II/VI holosystolic left apical heart murmur, a palpable abdominal fluid wave, and bruising on the ventral abdomen. Her blood pressure could not be obtained via Doppler. The CBC was similar to that performed prior to referral. Venous blood gas analysis (iSTAT EC8; Abbott Point of Care, Abbott Park, Illinois, USA) showed a metabolic acidosis [pH 7.281; RI: 7.35 to 7.45, base excess (BE) -10 mmol/L; RI: 0 to 6, hyponatremia (119 mmol/L; RI: 142 to 150)] and an elevated BUN (17.9 mmol/L; RI: 3.57 to 9.28 mmol/L). A prothrombin time (PT) (IDEXX Coag Dx analyzer; IDEXX Laboratories, Westbrook, Maine, USA) was 70 s; RI: 11 to 17 s, and a partial thromboplastin time (aPTT) was 209 s; RI: 72 to 102 s. Venous lactate was not measured. Measurement may have provided further support for the presumed hypoperfusion secondary to hemorrhagic shock.

The patient’s elevated BUN was presumptively due to renal hypoperfusion from hypovolemia. Urine specific gravity, which was not evaluated due to a large volume of peritoneal effusion and concern for coagulopathy making cystocentesis of increased risk, may have provided further support for the presumed hypovolemia. Urine specific gravity \( \geq 1.030 \) would rule out kidney dysfunction. The patient’s metabolic acidosis was likely due to

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hypoperfusion causing hyperlactatemia; however, uremic acidosis cannot be entirely ruled out. Hyperlactatemia was unconfirmed. However, the presence of base deficit characterized by the base excess algorithm indicates unmeasured anions are present and lactate is most logical in this patient’s case (8).

A universal type packed red blood cell (pRBC) transfusion was administered, followed by a fresh frozen plasma (FFP) transfusion [20 mL/kg body weight (BW)]. The dog’s blood pressure normalized at 120 mmHg (Doppler systolic) following administration of a 30-mL pRBC bolus (8.5 mL/kg BW) administered over 15 min. Following the FFP transfusion, crystalloid therapy was initiated with Plasmalyte-A (Abbott Animal Health, Abbott Park, Illinois, USA) with 20 mEq/L potassium chloride administered over 15 min. Following the FFP transfusion, crystalloid therapy was initiated with Plasmalyte-A (Abbott Animal Health, Abbott Park, Illinois, USA) with 20 mEq/L potassium chloride (Hospira, Lake Forest, Illinois, USA) at 7 mL/h (48 mL/kg BW per day). Post-pRBC transfusion the packed cell volume (PCV) was 0.24 L/L with total protein (TP) of 42 g/L, which rapidly declined over 6 h to 0.18 L/L and 40 g/L, respectively. The patient became clinical for the aforementioned anemia, displaying tachycardia (180 bpm), pallor, and quieter mentation. With evidence of clinical anemia, an additional PRBC transfusion (30 mL) was administered. Post-pRBC transfusion PCV was 0.30 L/L with a TP of 53 g/L. The PT and aPTT were normal at 15 s and 91 s, respectively. Epsilon aminocaproic acid (Hospira), 50 mg/kg BW, IV, q8h, was administered.

Laparotomy was elected to evaluate the ovariohysterectomy ligature sites. This patient was sedated with hydromorphone (West-Ward Pharmaceuticals, Eatontown, New Jersey, USA), 0.05 mg/kg BW, IV, prior to induction of anesthesia with propofol (Abbott Animal Health), 4.3 mg/kg BW, IV. The patient was intubated and maintained on Sevoflurane (Zoetis Animal Health, Florham Park, New Jersey) inhalant anesthesia. During surgery 280 mL of bloody fluid was evacuated from the abdomen. Blood clots were located around the uterine stump and ovarian artery ligations. All ligatures were intact. The uterine body was again ligated and Gel Foam (Pfizer, New York, USA) was applied to the right ovarian pedicle region. During surgery, 280 mL of bloody fluid was evacuated from the abdomen. Blood clots were located around the uterine stump and ovarian artery ligations. All ligatures were intact. The uterine body was again ligated and Gel Foam (Pfizer, New York, USA) was applied to the right ovarian pedicle region. There was no evidence of active hemorrhage. The abdomen was closed routinely and the dog recovered uneventfully. Post-operative pain was controlled with hydromorphone (West-Ward Pharmaceuticals), 0.05 mg/kg BW, IV, q4 to 6 h.

Due to the inability to rule out inherited coagulopathy and recent laparotomy, an additional FFP transfusion (17 mL/kg BW) was administered on recovery to assure adequate factor activity. Following completion of the post-operative FFP transfusion, intravenous fluid therapy was continued with the pre-operative crystalloid and rate.

Throughout the day post-surgery, the dog’s PCV remained stable between 0.33 and 0.36 L/L with her TP between 64 and 72 g/L. The dog was normotensive (110 to 156 mmHg) and her vital parameters were normal. Over the following 24 h, the dog’s vitals remained stable with PCV and TP of 0.37 L/L and 68 g/L, respectively. Hydromorphone was discontinued and tramadol (Amneal Pharmaceuticals, Bridgewater, New Jersey, USA), 3.5 mg/kg BW, PO, q8h was started.

A citrated whole blood sample collected ~36 h after the last FFP transfusion revealed PT and aPTT to be prolonged at 31 s and 139 s, respectively. The dog’s PCV was 0.38 L/L with a TP of 71 g/L. Citrated plasma was submitted to Cornell University Animal Health Diagnostic Center Comparative Coagulation Laboratory for coagulation factor analysis. The patient remained stable and was discharged 2 d after surgery with epsilon aminocaproic acid (Akorn Pharmaceuticals), 35 mg/kg BW, PO, q8h, tramadol, 3.5 mg/kg BW, PO, q12h, and vitamin K (VetOne, Boise, Idaho, USA), 3.5 mg/kg BW, PO, q24h. Factor analysis results revealed diminished factor X activity (45%; RI: 80% to 175%), with normal factor II, VII, VIII, IX, Von Willebrand factor and fibrinogen activity.

At recheck examination 16 d after surgery, the patient was reported to be acting normally following discharge. Repeat factor X analysis revealed persistent factor X deficiency (29%), consistent with congenital factor X deficiency. At 18 mo post-hemorrhage, the patient was reported to be clinically normal without evidence of hemorrhage with play or standard veterinary care (i.e., vaccinations). Recheck blood analysis revealed moderate factor X deficiency (37%). The PT and aPTT were prolonged, 37.3 s (RI: 10 to 17 s) and 51.6 s (RI: 11 to 16 s), respectively, compatible with factor X deficiency.

Discussion
This report describes the diagnosis and management of a patient with hemoperitoneum due to factor X deficiency. It notes a breed not previously reported. There are 2 previous reports of factor X deficiency in dogs, 1 in a family of American cocker spaniels, and 1 in a Jack Russell terrier (JRT). The JRT was also evaluated for hemorrhage after routine ovariohysterectomy but had significant hemorrhage with eruption of permanent dentition and required multiple plasma transfusions prior to evaluation. The JRT had significantly lower factor X (3% to 13%) compared to this patient (29% to 45%), likely explaining the more frequent and serious hemorrhagic events (6). The family of American cocker spaniels in which factor X deficiency in the dog was first described had factor X levels (18% to 68%) similar to this patient and displayed mild to moderate hemorrhage with frequent neonatal mortality. Autosomal dominant inheritance was displayed based on test breeding which differs from the autosomal recessive inheritance demonstrated in humans (7). It was also reported that homozygotes were more significantly affected than heterozygotes. This likely leads to underreporting of factor X deficiency due to severity of hemorrhage and death in homozygous puppies.

Factor X is produced in the liver and is dependent on adequate availability of vitamin K. Factor X is the start of the common pathway of the coagulation cascade, bridging the intrinsic and extrinsic pathways. Deficiency leads to prolongation in both PT and aPTT, as the common pathway is evaluated by both tests. These abnormalities were noted in this patient.

The cell-based model of coagulation elucidates the importance of adequate factor X. This model involves 3 phases of coagulation: initiation, amplification, and coagulation. Factor X is involved in producing small amounts of thrombin during the initiation phase during which it is activated by FVIIa/TF complex on a cell surface. Activated factor X (FXa) binds with FVa (prothrombinase complex) on the TF-bearing cells. Prothrombinase cleaves prothrombin (FII) to thrombin (FIIa).
Thrombin then diffuses from the TF-bearing cell and activates platelets (amplification). Activated platelets activate FV and FXI on the platelet surface. The FXa activates FIX allowing FXa to be formed on the activated platelet surface by FIXa/VIIa complex. The FXa then rapidly binds with FVa on the platelet surface to produce a burst of thrombin generation large enough to convert fibrinogen to fibrin (propagation) (6,9,10). Based on this model of coagulation, it is clear that the remainder of coagulation falters with factor X deficiency as it has a central role in generation of thrombin.

Acquired factor X deficiency must be ruled out before attributing decreased factor activity to an inherited disease. Liver failure, amyloidosis, anticoagulant rodenticide ingestion, and consumptive coagulopathy also must be ruled out. Initial laboratory tests indicated no evidence of hepatopathy with normal liver enzymes and bilirubin, elevated BUN, and low normal albumin. Hepatic failure was thought to be unlikely in this patient. If there had been concern for hepatic dysfunction, bile acids response test or ammonia level may have been considered.

Consumptive coagulopathy was an initial likely differential diagnosis with this patient’s history and recent surgical procedure. Consumptive coagulopathy occurs when clotting factors are consumed trying to control active hemorrhage. Another form of consumptive coagulopathy is disseminated intravascular coagulopathy (DIC), which occurs when clotting factors are consumed due to activation by inflammation without a source of hemorrhage. Hemorrhage is uncommon in DIC with organ dysfunction occurring more commonly. In this patient there was no source of significant inflammation to incite activation of systemic coagulation, aside from recent surgery, as the patient was reportedly healthy prior to ovariohysterectomy (11). This patient was initially suspected to have a consumptive coagulopathy due to hemorrhage into the abdomen from slipped ligature from recent ovariohysterectomy. This seemed logical with the prolongation in coagulation times and presence of intra-abdominal hemorrhage. Due to the extended time from ovariohysterectomy with the sudden clinical decline, slipped ligature alone did not fully explain the hemorrhage that occurred.

The patient displayed severe thrombocytopenia which could have predisposed her to the cavitary hemorrhage and secondary coagulopathy; however, thrombocytopenia is an uncommon source of cavitary hemorrhage, more commonly causing small petechial hemorrhage. Cavity hemorrhage may occur if severely thrombocytopenic patients undergo invasive procedures, such as ovariohysterectomy. Other signs of thrombocytopenia, such as melena, gingival, or petechial hemorrhage would have been suspected if this patient had been profoundly thrombocytopenic prior to surgery. As pre-ovariohysterectomy laboratory testing had not been performed, it is not possible to fully rule out that thrombocytopenia was pre-existing and contributed to cavitary hemorrhage. The patient had no other evidence of severe thrombocytopenia (i.e., petechia, melena, hematemesis); therefore, pre-existing severe thrombocytopenia is considered unlikely. Differentials for this patient’s thrombocytopenia outside of consumption via hemorrhage include immune mediated thrombocytopenia (primary and secondary) and primary bone marrow dysfunction.

The patient presented in hemorrhagic shock. Blood products were elected for stabilization over crystalloid fluids due to diagnosis of hemoperitoneum and severe anemia. In our hospital, universal packed red blood cells are always available for transfusion thereby eliminating the need for initial crystalloid therapy in favor of a product which would not only rectify the patient’s hypovolemia but also help to correct the severe anemia which was the cause of the patient’s clinical status. The patient’s blood pressure normalized after receiving a pRBC bolus and remained normal thereafter, indicating improved intravascular volume. Due to the diagnosis of coagulopathy, after completing the pRBC transfusion, it was elected to immediately begin an FFP transfusion. Crystalloid fluid therapy was not administered during this transfusion, or the pRBC transfusion, to limit the risk of transfusion associated circulatory overload due to the patient’s small size and relatively high fluid rates with both pRBC and FFP transfusions (102 mL/kg BW per day and 82 mL/kg BW per day, respectively).

This patient was pre-medicated for surgery with hydromorphone. Since this patient’s treatment, our hospital has begun to use methadone or fentanyl for premedication of the more critically ill patients due to fewer cardiovascular and respiratory side effects. If this patient presented to our hospital currently, the anesthetic protocol would likely be adjusted to include a fentanyl CRI throughout surgery to diminish inhalant requirement and minimize cardiovascular complications.

Classification of factor X deficiency categories are as follows in humans: severe (FX:C < 10%, spontaneous major hemorrhage), moderate (FX:C 10% to 40%, mild spontaneous or triggered hemorrhage), and mild (FX:C > 40%, mostly asymptomatic) (12). There is no classification scheme for veterinary patients. This patient’s initial factor activity level was higher than that reported in human medicine as a cause of coagulopathy, but residual factor activity from the FFP transfusion may have contributed to this result. All subsequent factor X levels were consistent with moderate factor X (29%, 37%) which correlates with the patient’s clinical status (development of hemorrhage after surgery). The factor X level noted in this study is similar to that of the previously reported cocker spaniels. This is likely due to a heterozygous condition, as heterozygotes are less prone to hemorrhage. Based on human literature, if this patient is heterozygous for factor X deficiency, her risk of clinical hemorrhage should be lower, which is supported by her tolerance of routine veterinary care and rough play. She remains at risk of hemorrhage with trauma or surgery and it is recommended she be treated prophylactically or therapeutically if these events occur.

Due to the rarity of this disease, research into therapy recommendations for factor X deficiency is lacking. For minor bleeds, topical hemostatic agents and antifibrinolytic therapy, have been recommended (1,13). For more serious hemorrhagic events, factor X replacement is required with FFP, cryosupernatant, prothrombin complex concentrate (PCC), or factor X concentrate (2,11,12,14). Prothrombin complex concentrate is a highly purified concentrate of coagulation factors, containing factors II, IX and X or II, VII, IX and X, in concentrations approximately 25 times that of FFP (12). Factor X concentrate and PCC are
unavailable in veterinary medicine; therefore, FFP remains the therapy of choice.

Fresh frozen plasma is not recommended for prolonged PT and aPTT alone, as these tests are not predictive of spontaneous hemorrhage, and in patients with inherited coagulopathy PT and aPTT are likely to be prolonged (15). However, in patients with prolonged PT and aPTT undergoing invasive procedures (i.e., aspiration of highly vascular organs or surgery), FFP is recommended to prevent clinically significant hemorrhage and the need for emergency transfusion therapy. As FFP transfusion is not benign it should only be used when clinically significant hemorrhage is on-going or expected (15).

In conclusion, inherited factor X deficiency caused development of hemoperitoneum and hemorrhagic shock following standard ovariohysterectomy in this dog but is rare in veterinary medicine. The patient was successfully treated with transfusion therapy and underwent uneventful laparotomy. Coagulation factor analysis is recommended in cases of unexpected hemorrhage, following treatment, to attempt to prevent future events of hemorrhage. Further study into the incidence of factor X deficiency is required to determine the prevalence and clinical relevance of this condition.

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References


Case Report  
Rapport de cas

Sialoendoscopy as a treatment for an obstructed mandibular salivary duct in a horse

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Abstract — A 14-year-old Quarter Horse was examined for a draining tract of 8 months’ duration on the right mandible that was non-responsive to antibiotic therapy and surgical therapy. Further investigation and subsequent treatment with sialoendoscopy and ultrasonography were performed to relieve an obstruction of plant awns in the mandibular salivary duct.

Résumé — Sialo-endoscopie comme traitement pour un canal salivaire mandibulaire bloqué chez un cheval.

Un cheval Quarter Horse âgé de 14 ans a été examiné pour une fistule purulente d’une durée de 8 mois à la mandibule droite qui ne répondait pas à la thérapie antibiotique et à la thérapie chirurgicale. De nouvelles investigations et le traitement subséquent à l’aide de la sialo-endoscopie et de l’échographie ont été réalisés pour éliminer un blocage du canal salivaire mandibulaire par des barbes de plantes.

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Case description

A 14-year-old, 450-kg female Quarter Horse was evaluated at the University of California, William R. Pritchard Veterinary Medical Teaching Hospital (VMTH) for a draining tract of 8 mo duration on the right caudal mandible that had intermittently been treated with an unknown dose of trimethoprim sulfamethoxazole (TMS). The draining tract was located 5 cm rostral of the ramus of the mandible and was on the medial aspect of the right hemi-mandible (Figure 1). The horse was kept on a dry pasture lot with access to supplemental grass hay. With the exception of the draining tract, physical examination was normal with no evidence of lymphadenopathy or nasal discharge. Radiographs of the mandible showed no evidence of a sequestrum, radio-opaque foreign body, or osteomyelitis. Ultrasonographic examination of the salivary structures revealed a suspected plant foreign body within the mandibular salivary duct without associated sialoadenitis. Oral examination did not reveal any dental abnormalities although the right sublingual caruncle was thickened and erythematous.

Due to the chronicity of the mandibular draining tract and poor response to antibiotics, surgery was undertaken to remove the foreign body. Under general anesthesia, a 5 French polyethylene catheter was inserted into the draining tract and an incision was made following the catheter to the salivary duct. A second 5 French catheter was introduced into the salivary duct orally via the sublingual caruncle and was flushed with sterile saline until the foreign body was retropulsed to the surgical opening in the duct. The foreign body was removed, and the salivary duct and surgical site were closed with a simple interrupted pattern. At the time of surgery a sample of purulent material from within the salivary duct was taken and cultured Pasteurella caballi and Treperella pyogenes, both of which were sensitive to TMS. The horse was discharged on a 1-month course of TMS (Trimethoprim and sulfamethoxazole; Amneal Pharmaceuticals, Hauppauge, New York, USA), 30 mg/kg body weight (BW), PO, q12h. Repeat examinations by the referring veterinarian over the next 6 mo showed that the discharge decreased but never ceased.

Examination at the VMTH 6 mo after surgery confirmed a right-sided, ulcerated, ∼2-cm diameter soft tissue mass caudal to the ramus of the right mandible with purulent material discharging from a 2-mm draining tract. No other abnormalities were found on physical examination. A repeat oral examination was performed and no abnormalities were noted except the erythematous and swollen right sublingual caruncle. Ultrasonographic examination of the region revealed multiple plant awn foreign bodies within the right mandibular salivary duct. The linguofacial vein was noted to be directly overlying the mandibular salivary duct complicating surgical access to the foreign bodies. Ultrasound-guided removal of the foreign bodies using endoscopic biopsy forceps passed orally through the sublingual caruncle to the site of obstruction was successful in removing 2 plant awns. Antegrade flushing via the patent draining tract was performed to allow for distention of the salivary duct and easy passage of the biopsy forceps for removal of...
additional plant awns. Repeat ultrasonographic evaluation after distention of the duct confirmed multiple additional foreign bodies within the salivary duct (Figure 1). The owner consented to additional diagnostics, and sialoendoscopy was scheduled for the following day.

At the time of sialoendoscopy, an Alumispec equine speculum (Veterinary Dental Products, Elmwood, Wisconsin, USA) was placed to facilitate access to the oral cavity. Incremental doses of detomidine (Pfizer, New York, New York, USA) and butorphanol (T orbugesic; Zoetis, Fort Dodge, Iowa, USA) were given via a jugular intravenous catheter to achieve adequate sedation. A 2.5-mm diameter endoscope was introduced into the right mandibular salivary duct through the right sublingual caruncle. The lumen of the duct was noted to be severely erythematous with large amounts of fibrin likely due to a chronic active inflammatory process (Figure 2). Lidocaine (Lidocaine hydrochloride 2%; VetOne, Boise, Idaho, USA), 20 mL, was infused into the duct to facilitate passage of the endoscope. Multiple foreign bodies (plant awns and hay) were noted along the length of the duct from the caruncle to the draining tract. Dilute betadine was infused via the draining tract to dilate the salivary duct to aid with visualization and foreign bodies were removed using biopsy forceps through the biopsy channel in the endoscope. The procedure was continued for 2 h and approximately 20 plant awns and multiple blades of hay were removed. Multiple plant awns were still present within the salivary duct, but the treatment was discontinued due to the length of the procedure and the amount of sedation administered. Dexamethasone SP (VetOne, Meridian, Idaho, USA), 0.2 mg/kg BW, was infused into the duct to reduce inflammation and the horse was discharged with dexamethasone (VetOne), 0.04 mg/kg BW, PO, q24h, flunixin meglumine (Merck Animal Health, Intervet, Summit, New Jersey, USA), 0.5 mg/kg BW, PO, q12h, and TMS (Amneal Pharmaceuticals), 30 mg/kg BW, PO, q12h. The owners were instructed to feed a pelleted diet and to eliminate access to pasture to reduce exposure to hay and plant awns. Re-examination was scheduled for 2 wk later.

At re-examination the draining tract on the mandible was reduced in size but was still present. The 2.5-mm endoscope was passed into the right sublingual caruncle and a stricture was noted at 10 cm from the ostium that would not allow passage of the endoscope. Multiple foreign bodies (plant awns and hay) were noted along the length of the duct from the caruncle to the draining tract. Dilute betadine was infused via the draining tract to dilate the salivary duct to aid with visualization and foreign bodies were removed using biopsy forceps through the biopsy channel in the endoscope. The procedure was continued for 2 h and approximately 20 plant awns and multiple blades of hay were removed. Multiple plant awns were still present within the salivary duct, but the treatment was discontinued due to the length of the procedure and the amount of sedation administered. Dexamethasone SP (VetOne, Meridian, Idaho, USA), 0.2 mg/kg BW, was infused into the duct to reduce inflammation and the horse was discharged with dexamethasone (VetOne), 0.04 mg/kg BW, PO, q24h, flunixin meglumine (Merck Animal Health, Intervet, Summit, New Jersey, USA), 0.5 mg/kg BW, PO, q12h, and TMS (Amneal Pharmaceuticals), 30 mg/kg BW, PO, q12h. The owners were instructed to feed a pelleted diet and to eliminate access to pasture to reduce exposure to hay and plant awns. Re-examination was scheduled for 2 wk later.

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were in 50% of their cases. In the current case the bacteria cultured along with other aerobic and anaerobic bacteria were cultured as a predisposing factor. They showed that 33% of cases of septic sialoadenitis had a sialolith and their associated ducts, although advanced ultrasonographyskills are required (3). The use of ultrasonography in this case allowed complete evaluation of the salivary glands and ducts and aided in the visualization of foreign bodies. Dynamic ultrasound was used to manipulate and remove the plant awns although the technique underestimated the number of plant awns, present in the salivary duct due to superimposition and progressive gas accumulation within the duct. Sialoendoscopy was therefore required for identification of location and extent of multiple foreign bodies. Other potential diagnostics indicated advanced imaging modalities (computed tomography or magnetic resonance imaging) although these both frequently require general anesthesia and the inherent risks associated with anesthesia. In the case herein, the opening of the mandibular salivary duct into the oral cavity was located under the tongue 3 cm rostrolateral to the lingual frenulum at the sublingual caruncle. Cannulation was achieved using a 5 French polyethylene catheter and lavage was performed with a sterile saline solution. Cannulation and use of the endoscope was facilitated by a widened sublingual caruncle on the right side compared with the left. The widening was speculated to be due to the chronic inflammation and infection. A 2.5-mm endoscope was used for visualization although in some cases a smaller endoscope may be required.

Indications for sialoendoscopy include diagnostic evaluation of sialadenitis, unexplained swelling or draining tracts at the ramus of the mandible, salivary gland swelling, or localization of a sialolith. Sialoendoscopy has been described to aid in sialolith retrieval or fracture using lithotripsy in humans (4). The only contraindication to the technique is in acute sialadenitis as the use of an endoscope, dilator systems, or irrigation could increase the likelihood of spread of infection or stenosis in humans (5).

Strictures of the salivary duct are complications that occur secondary to inflammation, infection, and trauma during surgical procedures and can limit the use of sialoendoscopy in humans (6). In the present case we were able to pass the endoscope through the stricture by using the biopsy forceps as a guide wire and a stabilizing instrument. The administration of topical and systemic dexamethasone was intended to reduce inflammation and the risk of stricture formation within the salivary duct. Although no studies have been performed on the efficacy of steroids in reducing the risk of stricture formation in salivary ducts (7), the efficacy of intralesional steroids in reducing the risk of recurrence in esophageal strictures has been confirmed in humans (8) and this approach has been attempted in horses (9), and extrapolated to this case.

The precise etiology of the salivary duct obstruction in this case was unclear. It was speculated that the diet consisting of large amounts of plant awns initially led to migration of an awn into the salivary duct. This initial migration may have subsequently lead to dilatation of the duct allowing for migration of more awns.

Sialoendoscopy is a novel technique not previously reported in the veterinary literature as both a diagnostic and treatment modality. The technique allowed complete resolution of a chronically obstructed mandibular salivary duct which would otherwise have required extensive surgery for resolution. The awns was unsuccessful. The endoscope was inserted into the draining tract and approximately 15 to 20 grass awns were removed via the draining tract using endoscopic biopsy forceps. After 2.5 h multiple plants awns were still visible in the duct but significant hyperemia and inflammation developed resulting in discontinuation of the procedure. Dexamethasone SP (VetOne), 0.2 mg/kg BW, IV, was infused into the right salivary duct to reduce inflammation and the horse was discharged on the same medications as described previously. Sialoendoscopy was performed a week later and additional plant awns were removed from the salivary duct until none were visualized. Re-examination was performed 2 wk later confirming resolution of the draining tract and a patent salivary duct. At this time all medications were discontinued and the owner was advised to continue to restrict the horse's diet to pellets and eliminate pasture access to reduce the risk of hay or plant awn intake. Six months following discharge the horse was reported to be clinically normal with no draining tract present.

This is the first report of the use of sialoendoscopy and dynamic ultrasound for the diagnosis and removal of foreign bodies within the mandibular salivary duct. Septic sialoadenitis (1) is an uncommonly reported disease in the horse with limited treatment options available. In a recent study, Kilcoyne et al (1) showed that 33% of cases of septic sialoadenitis had a sialolith as a predisposing factor. They showed that *Fusobacterium sp.* along with other aerobic and anaerobic bacteria were cultured in 50% of their cases. In the current case the bacteria cultured were *Pasteurella caballi* and *Truperella pyogenes* indicating that other bacteria may also be involved.

Diagnosing the underlying etiology of draining tracts in the mandibular region is difficult due the complex anatomy of the skull. Radiography is limited by summation and superimposition when looking for small foreign bodies although large, or radio-opaque sialoliths can be seen on radiographs (2). Ultrasound can be used for examination of the salivary glands and their associated ducts, although advanced ultrasonography

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**Figure 2.** Mandibular salivary duct showing severe erythematous mucosa and fibrin accumulation. Plant material can also be seen.
procedure was well-tolerated by the horse in this case with standing sedation; therefore, bypassing the risk of general anesthesia.

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References
Case Report Rapport de cas

Ventral rhinotomy in a pet rabbit (*Oryctolagus cuniculus*) with an odontogenic abscess and sub-obstructive rhinitis

Tamara Brown, Hugues Beafrère, Brigitte Brisson, Delphine Lanie, Alex zur Linden

Abstract — A rabbit was presented for severe dyspnea and was diagnosed with an odontogenic abscess obstructing the rostral nasopharynx using CT scan and oral endoscopy. The offending tooth was extracted intraorally, but due to persistent dyspnea, an endoscopic-guided ventral rhinotomy was performed. The dyspnea subsequently resolved, but the rabbit died 5 weeks later from a seemingly unrelated cause.

Résumé — Rhinotomie ventrale chez un lapin de compagnie (*Oryctolagus cuniculus*) atteint d’un abcès odontogène et d’une rhinite causant une subocclusion. Un lapin a été présenté pour une dyspnée grave et a été diagnostiqué avec un abcès odontogène bloquant le nasopharynx rostral par tomodensitométrie et endoscopie orale. La dent en cause a été extraite intra-oralement, mais, en raison d’une dyspnée persistante, une rhinotomie ventrale guidée par endoscopie a été réalisée. La dyspnée s’est subséquemment résorbée, mais le lapin est mort 5 semaines plus tard d’une cause apparemment non reliée.

Case description

A 1.5-year-old neutered male lop-eared rabbit (*Oryctolagus cuniculus*) was presented to the Ontario Veterinary College — Health Sciences Centre for chronic respiratory signs and dyspnea that had suddenly worsened over the previous 2 d. The owner reported open-mouth breathing, a right-sided rhinorrhea, and epiphora.

On physical examination, the rabbit was quiet, alert, and responsive. The rabbit weighted 2.6 kg (body condition score 4/5) and was over-conditioned. Mucous membranes were pink initially but rapidly became cyanotic after manual restraint with the rabbit displaying an orthopneic position with the head and neck extended. No ocular or nasal discharge was observed and abdominal palpation was within normal limits. On auscultation over the nasal cavities, increased respiratory noises were heard. Pulse oximetry revealed SpO₂ oscillating between 60% and 70% during restraint. The rabbit was placed in an enriched-oxygen chamber providing a PO₂ of 40% to 50% measured with an oxygen probe.

Figure 1. Lateral radiographic view of a rabbit skull demonstrating a round, soft tissue opacity (black arrows) with a radiolucent center (white arrow) superimposed with the nasal cavity. Other abnormalities visible include mildly elongated reserve and clinical crowns of incisors, premolars, and molars, mild incisor malocclusion, mild clinical crown elongation of the peg teeth, and an apical lucency associated with an M3.

The following morning, the rabbit was sedated with midazolam (Versed; Roche Labs, Basel, Switzerland), 1.5 mg/kg body weight (BW), IM and butorphanol (Torbugesic, Zoetis, Kirkland, Quebec), 1 mg/kg BW, IM, for radiographs. Radiographs of the skull revealed mild incisor and cheek teeth malocclusion including mildly elongated reserve crowns of premolars, molars, and lower incisors, altered incisor dental plane, elongated peg teeth, and a rounded soft tissue opacity with a radiolucent centre superimposed with the nasal cavity (Figure 1). Thoracic radiographs were unremarkable. While the rabbit was sedated, blood was collected from the saphenous vein for a complete blood (cell) count (CBC), which was within reference intervals. A cursory dental examination using an otoscope was then performed. The right upper first premolar had a short clinical crown with mild corresponding point on its mandibular
counterpart. A deep nasal swab was taken from the left nostril for aerobic culture and sensitivity, which yielded no growth.

The initial therapeutic plan included enrofloxacin (Baytril; Bayer Healthcare, Mississauga, Ontario), 10 mg/kg BW, PO, q12h, metronidazole (Flagyl; Pfizer, New York, New York, USA), 20 mg/kg BW, PO, q12h, meloxicam (Boehringer Ingelheim, Burlington, Ontario), 1 mg/kg BW, PO, q24h, oxygen therapy, and Lactated Ringer’s solution (LRS) at a maintenance rate (100 mL/kg BW per day) subcutaneously. While receiving oxygen, the rabbit’s breathing and cyanosis improved, which correlated with a SpO2 above 90%. The rabbit’s appetite and fecal production were maintained with normal fecal pellet consistency and amount. Each time the rabbit was removed from the oxygen chamber for treatment, it became cyanotic, which resolved once it was replaced in the oxygenated enclosure.

On the third day of hospitalization, since no significant improvement of the breathing was observed, a CT scan of the head and neck was used to evaluate the upper airways. The rabbit was sedated with midazolam (1.5 mg/kg BW, IM) and butorphanol (1 mg/kg BW, IM), placed in ventral recumbency, and a 16 slice CT scan (GE Bright Speed; General Electric Healthcare, Milwaukee, Wisconsin, USA) was performed. Images were reformatted with routine bone and soft tissue algorithms. Slice thickness was 0.625 mm and images were reformatted into 1.25 mm slices. The field of view was 25 cm, kVP 120, mA 100. The pitch was 0.938:1 with a 1 s rotation time. Iopamidol (Isovue; Bracco Diagnostics, Princeton, New Jersey, USA), 2 mL/kg BW, IV, was administered via a 24 g IV catheter placed in the marginal ear vein. The CT scan confirmed the presence of a lesion and associated osteomyelitis of the maxillary bone at the level of the first maxillary premolar (PM1) on the right side (Figure 2). The tooth was almost completely lysed except for a fragment of the reserve crown embedded in the gingiva. Lysis of the surrounding alveolar bone of the

Figure 2. Computed tomography views of the head of a rabbit presented for dyspnea. A – Pre-contrast paramedian sagittal view, bone window (WW 2000/WL 350). The right rostral maxillary premolar (PM1) is mostly lysed with only a fragment of the reserve crown remaining (black arrow). Dorsal to PM1 is a visible abscess originating from the reserve crown and invading into the right nasal cavity (white arrow). B – Pre-contrast transverse image, bone window (WW 2000/WL 350). The abscessation is visible originating on the right side in the right maxillary recess (top white arrow) and extending medially into the rostral nasopharynx/caudal ventral nasal meatus (bottom white arrow) and right nasal cavity. C – Sagittal median view, bone window (WW 2000/WL 350). The abscess is clearly seen nearly completely obstructing the lumen of the rostral nasopharynx. D – Pre-contrast transverse image, bone window (WW 2000/WL 350). The abscess almost completely obstructed the airway at the rostral nasopharynx with only 1 to 2 mm of residual lumen (white arrows). White dotted lines on A and C represents transverse sections on B and D and are labelled accordingly.
The lesion was soft tissue/fluid dense and measured 10 mm × 12 mm × 12 mm. It extended into the rostral nasopharynx/caudal nasal ventral meatus from the right nasal cavity, its maxillary recess, and the premolar periapical area (1). There was a moderate contrast enhancement at the periphery of the lesion. The lesion, suspected to be an odontogenic abscess, almost completely obstructed the airway at the caudal aspect of the right nasal cavity and the rostral nasopharynx. Other differentials for the lesion included foreign body, cyst, and neoplasia. Other findings on the CT scan were similar to the skull radiographs and included reserve crown elongation of the mandibular and maxillary cheek teeth.

On the same day, after interpretation of the CT, the rabbit was induced with alfaxalone (Alfaxan; Jurox, Kansas City, Missouri, USA), 5 mg/kg BW, IV, and intubated with a 3.0 mm uncuffed endotracheal tube using the over-the-endoscope technique with a 2.7 mm, 30° angle rigid endoscope (Karl Storz Veterinary Endoscopy, Goleta, CA, USA), and maintained on isoflurane general anesthesia. End-tidal CO₂ was monitored with a pediatric main stream capnograph (Micropack; Covidien, Federal Way, Washington, USA); heart rate was monitored with a Doppler unit, and oxygen saturation was monitored using a pulse oximeter. An endoscopy-guided dental examination was performed using a 5 mm diameter 0 degree angle video otoscope (Karl Storz Veterinary Endoscopy, Mississauga, Ontario) with the rabbit placed on a dental table (Rodent table; Sontec Instruments, Centennial, Colorado, USA) and using a rodent cheek spreader (Rodent cheek dilator — large, Jorgensen Labs, Loveland, Colorado, USA). There was a lingual point noted on the right mandibular PM1 clinical crown due to lack of normal wearing since the corresponding upper right PM1 had no visible clinical crown. The tooth was trimmed using a diamond burr mounted on a low-speed rotating straight handpiece (XL-30W; Osada, Los Angeles, California, USA). Other premolars and molars appeared normal. The remnant of the right maxillary PM1 was visualized and removed with a dental scaler (Columbia curette 4R/4L; Sontec Instruments) using gentle debridement, as the CT scan had revealed that it was mostly resorbed and barely attached. Further debridement was performed in an attempt to remove more purulent material contained within the abscess (confirming the diagnosis of an odontogenic abscess). An aqueous 0.05% chlorhexidine solution was injected into the abscess pocket via a 24-gauge catheter to flush out purulent material. The airway was protected with a square gauze placed caudal to the site. Approximately 0.05 mL of medical honey (Medihoney; DermaSciences, Princeton, New Jersey, USA) was injected into the abscess with a 22-gauge catheter for its antibacterial properties (2). Buprenorphine (Buprenex; Reckitt-Benckiser, Mississauga, Ontario), 0.05 mg/kg BW, SC, was given twice q8h and meloxicam, 1 mg/kg BW, PO, q24h, were given for analgesia after the dental procedure (3–5) PO, q24h. Other treatments at this stage included syringe feeding with Oxbow Critical Care (Oxbow Animal Health, Murdock, Nebraska, USA), subcutaneous fluid therapy (LSR), oxygen therapy, and procaine penicillin G (Procaine Penicillin G; Dominion Veterinary Laboratories, Winnipeg, Manitoba).

There was no improvement after the dental procedure and it was decided that further surgical debridement was necessary. According to the topography of the abscess and nasal obstruction, and the rabbit’s skull anatomy, an endoscopic-guided ventral rhinotomy approach was elected and performed 6 days after presentation.

The rabbit was sedated with midazolam, 1.5 mg/kg BW, IM, and hydromorphone (Hydromorphone hydrochloride; Wolters Kluwer, Baltimore, Maryland, USA), 0.1 mg/kg BW, IM. A 24-gauge intravenous catheter was placed in the marginal ear vein of the left ear and the rabbit was induced with alfaxalone IV titrated to effect (5 mg/kg BW, IV). The rabbit was intubated with a 3.0 mm cuffed endotracheal tube as previously described and placed under isoflurane general anesthesia. The rabbit’s heart rate was monitored with a Doppler and an electrocardiogram (ECG), and ventilation was performed using a pressure controlled ventilator (Vetronics Small Animal Ventilator; BASi, West Lafayette, Indiana, USA). An arterial catheter was placed in the central ear artery of the right ear to directly monitor blood pressure. The rabbit received intravenous fluids (LSR 10 mL/kg BW per hour) and fentanyl citrate (Fentanyl citrate; Sandoz, Boucherville, Quebec), 10 µg/kg BW per hour, continuous rate infusion (CRI) for pain. The rabbit was kept on a heating pad throughout the surgery and the temperature was monitored using a rectal probe.

The rabbit was positioned in lateral recumbency. A rodent mouth gag (Jorvet) was used to open the mouth and a rodent cheek dilator (large) (Jorvet) was introduced into the oral cavity. A 30° 2.7-mm endoscope was used to visualize the oral cavity and guide the surgical approach. A small cavity was found in place of the dental extraction site with no purulent discharge. A number 15 scalpel blade was used to make a 1-cm incision midline on the hard palate over the palatal ridges centered just rostral to the first maxillary premolar and over the palatal fissure of the incisive/maxillary bones as per the location of the lesion on the CT images. The rostral rhinopharynx was penetrated and a small Meyerhoefer curette and a Frazier suction tip were used to expose, debride, and remove the abscessed tissues and purulent material under endoscopic guidance. Following debridement, the cavity, primarily composed of the rostral nasopharynx and right maxillary recess, was explored using the endoscope to ensure complete removal of the abscess and to lavage the abscess pocket (Figure 3). An 18-gauge catheter was used to flush the cavity with 0.9% NaCl under continuous suction. The walls of the abscess appeared to have been completely debrided and the turbinates were displaced but intact. Minimal to moderate blood loss was encountered. The site of the abscess was packed with approximately 2 mL of poloxamer 407 gel (Pluronics F-127; Sigma Aldrich, Oakville, Ontario) combined with gentamicin (Gentocin; Merck Animal Health, Madison, New Jersey, USA), 7.7 mg/kg BW, and cefazolin (Cefazolin sodium; Teva, Toronto, Ontario), 100 mg/kg BW, to achieve sustained release topical antibiotic therapy. The palatine soft tissue was sutured with 5-0 PDS (PDS polydioxanone; Ethicon, Somerville, New Jersey, USA) in a simple interrupted pattern. The purulent material retrieved from the abscess was submitted for aerobic and anaerobic culture and sensitivity, but no organisms were isolated.
The rabbit recovered without complication after the surgery and was maintained on fluids (Plasmalyte A and 2.5% dextrose), 10 mL/h, and the fentanyl CRI (2 μg/kg BW per hour) for 3 h after surgery. Since the dyspnea completely resolved after recovery from anesthesia, oxygen supplementation was discontinued. Only mild sneezing was observed that evening. The rabbit received buprenorphine, 0.03 to 0.05 mg/kg BW, SC, q6h, for pain control until the morning after surgery. The rabbit was syringe fed Oxbow Critical Care (Oxbow Animal Health) 60 mL twice a day. A reevaluation was scheduled 1 wk later.

At re-evaluation, the rabbit was reported as having soft stools and was otherwise bright and alert with no apparent dyspnea. Oral examination under manual restraint did not identify any new findings. Nebulizations were continued but antibiotic therapy both parenterally and by nebulization were discontinued in case iatrogenic gastrointestinal dysbiosis was the cause of the soft stools. The stools improved thereafter. A week later, the rabbit experienced an episode of dysorexia and soft stools with mild to moderate gastrointestinal bloating. It was managed conservatively with supportive therapy that included metronidazole, 20 mg/kg BW, PO, q12h, enrofloxacin, 10 mg/kg BW, PO, q12h, meloxicam, 1 mg/kg BW, PO, q24h, penicillin G procaine, 80 000 U/kg BW, SC once every 3 d, and the owner was instructed to perform nebulizations with 0.05 mL amikacin (250 mg/mL) and 5 mL of Plasmalyte A for 15 min twice a day. A reevaluation was scheduled 1 wk later.

Three weeks later, the rabbit was presented to an emergency clinic for anorexia and lethargy. On presentation it was flaccid and unresponsive, with a normal heart rate, temperature, and respiration rate. No dyspnea was noted. The rabbit’s last stools had reportedly been normal. The rabbit died at the emergency clinic the following morning from cardiac arrest due to an unknown cause. The owner declined necropsy; however, a postmortem oral examination was performed with an endoscope. The teeth were unremarkable and the surgical site over the hard palate appeared to have healed well.

**Discussion**

This report describes the occurrence and short-term resolution of an obstructive odontogenic rhinitis using a minimally invasive endoscopic-guided ventral rhinotomy performed intraorally through the palatal fissure of the incisive/maxillary bones. To the authors’ knowledge, this surgical procedure has not been reported in rabbits previously. Despite the death of the patient due to an unknown cause 5 wk after the surgery, the procedure was successful at immediately re-establishing normal upper airway patency, thus relieving the dyspnea, and allowed full debridement of the odontogenic abscess. Because of the short follow-up period, it is unknown whether the abscess would have recurred.

Odontogenic abscesses are common in rabbits with late-stage dental malocclusion but can occur at any stage (6–8). The pathogenesis of odontogenic abscesses involves food and bacteria being able to track up a loosened or broken tooth into the periodontal tissues and alveolar socket, resulting in the formation of an abscess associated with the maxilla or mandible (6,7,9). Odontogenic abscesses have been found to be comprised of a mixture of Gram-negative anaerobes (e.g., *Fusobacterium* spp., *Bacteroides* spp.), Gram-positive anaerobes (e.g., *Actinomyces* spp.), and Gram-positive aerobic cocci (e.g., *Streptococcus* spp.)
These abscesses can extend to any structure of the head in close proximity to the dental reserve crowns and apical areas. While typically associated with a mandibular or maxillary cheek tooth, odontogenic abscesses are less commonly located in the retrobulbar area, nasal cavity, and other deeper structures of the head.

Treatment options for odontogenic abscesses include tooth extraction, surgical debridement of the abscess, injectable penicillins, antibiotic impregnated polymethylmethacrylate (AIPMMA) beads, or other antibiotic-impregnated materials. For aerobic bacteria, antibiotic therapy should be based on culture and sensitivity. For anaerobic bacteria, since most laboratories do not provide sensitivity, antibiotics with good anaerobic spectrum should be selected.

Rabbits are obligate nasal breathers and any obstruction of the upper airway may lead to severe dyspnea. Clinical signs of an obstructed nasal cavity include wheezing and increased respiratory effort. Rhinitis and upper respiratory disease can occur secondarily to dental disease such as odontogenic abscesses. Therapeutic options for odontogenic abscesses extending into the nasal and sinusal cavities of the rabbit are more limited than for standard odontogenic abscesses. Due to the inspissated nature of lagomorph pus, systemic antibiotic therapy is often insufficient to treat purulent rhinitis; therefore, surgical debridement through a rhinotomy may be indicated. Dorsal and lateral approaches have been described in rabbits, cats, and dogs, and an intraoral palatal approach (ventral rhinotomy) has been documented in dogs, cats, and prairie dogs for the treatment of nasal empyema of odontogenic origin or odontoma. In some cases, a urethral catheter is placed and secured in the rhinotomy site for continued treatment and flushing after surgery, or a temporary rhinostomy is performed.

When treating an abscess or an empyema through a rhinotomy approach, the surgical approach must be sufficiently extensive to accommodate the instruments used for debridement and curettage. Imaging including radiography, computed tomography, and rhinoscopy are useful to determine the extent of the rhinitis and to select the best surgical approach and location to better target the infected tissue and minimize iatrogenic trauma to the intranasal structures. The intraoperative use of a small diameter rigid endoscope may also allow magnification and a better visualization of the surgical site and nasal cavity in smaller patients such as companion exotic mammals.

Rhinitis and respiratory distress were present secondarily to the odontogenic abscess in this patient. This is different from previous cases of empyema in the nasal cavity, which involved diffuse accumulation of pus rather than walled off and circumscribed abscesses. Due to the topography of the odontogenic abscess causing the rhinitis and nasal obstruction in this rabbit, a dorsal rhinotomy approach was thought to be too invasive and would have induced unnecessary disruption of the nasal bone, dorsal nasal concha, and likely the ventral and medial nasal conchae. A lateral approach (parahinotomy) through the perforated lateral surface (facies cribrosa) of the maxillary bone could have been performed as most of the abscessation was rostral to the premolars. However, it was determined to be more invasive than the selected ventral approach as it would have resulted in a deeper incision and the potential disruption of dental alveolar and apical structures. Despite there being no documentation regarding ventral rhinotomies in rabbits, an

Figure 4. Surgical approach outlined on a ventral view of a rabbit skull (A,C,E,G) and a rabbit cadaver (B,D,F,H) as viewed through a rigid endoscope, the rostral aspect is to the bottom. A and B display the ventral intra-oral topographic anatomy (palatal surface). C, E, and G – the endoscope is further inserted into the palatine fissure with corresponding soft tissue views on D, F, and H. D – an incision on the hard palate over the palatine fissure was made as outlined on A and B (red dotted line). F – a mosquito forceps is used to open the surgical incision. G and H – the inside of the rostral nasopharynx is seen. PPM – palatine process of the maxillary bone; PPI – palatine process of the incisive bone; PF – palatine fissure; MB – maxillary bone; IB – incisive bone; NS – nasal septum; NC – medial nasal concha.
Intraoral palatal approach was selected based on the location of the abscess invading ventromedially from the right into the nasal cavity maxillary recess and the rostral rhinopharynx/caudal ventral nasal meatus (as demonstrated on CT scan), and the experience of the surgeon involved using this approach in dogs and cats. The palate of the rabbit, composed of the maxillary bone caudally and the incise bone rostrally has a fenestrum, the palate fissure, allowing a surgical incision into the nasal cavity via the palate without the need to perform an osteotomy or disrupt any other structures, making it the least traumatic option (Figure 4) (18). This novel surgical approach was minimally invasive and provided adequate access to the abscess for debridement while the use of endoscopic guidance allowed magnification and increased visualization. Potential disadvantages of a ventral rhinotomy approach in the rabbit include the reduced space in the rabbit oral cavity, and the inability to leave the incision open and marsupialize the abscess.

There is little documentation on the use of poloxamer 407 gel in veterinary medicine, especially in rabbits. Poloxamer gel is an amphiphilic material that is semisolid at room temperature and acts as an emulsifier, solvent, and lubricant for many drugs (19). Poloxamer gel mixed with a variety of antimicrobials has been used to treat rhinitis or dental abscesses in a few species, but this use has not been described in rabbits (20–22). There are reports of its use as a carrier agent for experimental drugs and models in the nasal cavities of rabbits, where it has been well-tolerated (20,23). In this case, it was used as a medium to slowly release antibiotics directly into the surrounding tissue as an alternative to creating a temporary rhinostomy or using a catheter to access the abscess site for repeated flushing post-surgery.

The minimally invasive, endoscopic-guided ventral rhinotomy approach allowed successful debridement of the abscess with immediate resolution of the dyspnea after surgery. The patient had a good recovery, was discharged less than 2 d after surgery and the surgical site healed without complication. The abscess cavity seen at the 1-week re-evaluation and the subsequent hospitalization for dysorexia and diarrhea was suspected to be caused by dysbiosis. Oral and subcutaneous antibiotic administration often leads to dysbiosis in rabbits. Inadequate amounts of fiber intake during recovery may also have contributed to the dysbiosis. The abscess site was removed with supportive care and discontinuation of the antibiotics, supporting that presumptive diagnosis. The cause of the rabbit’s sudden presentation of lethargy, anorexia, and its sudden death 5 wk after the surgery remain unknown. The postmortem endoscopic oral examination revealed minimal signs of malocclusion and a healed surgical site; it is therefore less probable that the sudden illness and death were caused by the initial dental malocclusion or rhinotomy procedure. However, in the absence of a complete postmortem examination, we cannot rule out that death occurred as a complication of the dental disease and periapical infection such as hematogenous infection or septic emboli. Furthermore, the subsequent diarrhea and dysorexia were managed conservatively and another underlying medical condition could not be ruled out. The death of this rabbit creates a major limitation in knowing the long-term success of this novel minimally invasive endoscopic-guided ventral rhinotomy approach, which should be further investigated with longer follow-up periods.

References

Non-invasive magnetic resonance imaging diagnosis of presumed intermedioradial carpal bone avascular necrosis in the dog

Sarah L. Pownder, Stacy Cooley, Kei Hayashi, Abraham Bezuidenhout, Matthew F. Koff, Hollis G. Potter

Abstract — A 5-year-old, spayed female Weimaraner dog was evaluated for progressive left forelimb lameness localized to the carpus. Magnetic resonance imaging (MRI) was used to arrive at a presumptive diagnosis of intermedioradial carpal (IRC) bone fracture with avascular necrosis (AVN). To the authors’ knowledge, this is the first report of naturally occurring AVN of the canine IRC diagnosed using MRI.

A vascular necrosis (AVN) is uncommonly diagnosed in canine carpal bones (1,2). The diagnosis is challenging due to the small, complex anatomy of the canine carpus and primary use of radiographs for carpal evaluation. This case introduces Magnetic Resonance Imaging (MRI) as a means to non-invasively assess AVN in the canine carpus.

Case description
A 5-year-old, spayed female Weimaraner dog was presented with the following history. The dog had progressive left forelimb lameness of 6 mo duration. Initial assessment revealed no carpal pain, swelling, or crepitus. A non-steroidal anti-inflammatory drug (NSAID) was prescribed. Lameness progressed to non-weight-bearing and carpal swelling developed. A 30-day course of doxycycline was prescribed as a SNAP 4DX test (IDEXX Laboratories, Westbrook, Maine, USA) and a C6 peptide antibody titer were positive for borreliosis. According to the record, 1 mo later, radiographs were reported to have shown soft tissue swelling, focal periosteal reaction, and an irregular intermedioradial carpal (IRC) articular margin. Comparative radiographs of the right carpus were also abnormal, showing a defect of the distal and dorsal margin of the radius with a corresponding osseous fragment consistent with prior trauma. Synovial fluid assessment of the left carpus was reportedly diagnostic for non-infectious inflammation. Regional biopsy revealed normal collagenous connective tissue. Gabapentin was added to control pain.

The patient was referred for additional diagnostics. A full examination revealed a grade 2/5 left forelimb lameness at walk, left carpal swelling with decreased flexion, and mildly decreased extension with pain on palpation. The right carpus had similar flexion-extension abnormalities without pain.

Based on history, radiographs, laboratory work, and physical examination, differential diagnoses included degenerative joint disease, prior trauma, or congenital carpal abnormality, with abductor pollicis longus tenosynovitis to explain the medial soft tissue swelling. Follow-up left carpal radiographs demonstrated increased opacity, trabecular consolidation, and decreased height of the IRC compared to the right (Figure 1), consistent with collapse. Prominent dorsomedial soft tissue swelling was consistent with the site of the reported biopsy. Mineralization and osteophytes were noted, predominantly along the medial margin of the carpus. Radiographs of the right carpus demonstrated thick soft tissues with large mineralization at the carpo-metacarpal joints and cranial margin of the distal radius (not shown).

Magnetic resonance imaging was performed (Table 1) using a 1.5T Vantage Atlas MRI (Toshiba, Tusinit, California, USA). The left IRC bone displayed diffuse bone marrow edema on...
fat-suppressed images with low signal intensity on the water sensitive pulse sequences, consistent with diminished vascularity without complete bone devitalization (Figure 2). A short fracture line was identified in the mid-body and seen when evaluated on transverse plane images sequentially (not shown). Additionally, spicules of increased signal intensity and the collapse of the IRC bone supported a fracture. The collapse did not support a neoplastic process as there was no expansion from within the bone. Although a congenital abnormality may produce an abnormal shape to the IRC bone, the central aspect of such a bone would still be anticipated to demonstrate normal marrow signal. The appearance did not support an isolated degenerative process as there was characteristic sparing of the opposing articular margins. The appearance of the IRC bone on MRI was consistent with AVN, fracture, and collapse as has been demonstrated in the human condition. Decreased marrow signal has been shown to correspond histologically with non-viable trabeculae, diminished osteoid, and loss of osteocytes in human cases of carpal AVN (3). Magnetic resonance imaging is useful in diagnosing carpal AVN and may allow an earlier diagnosis than with standard radiographs (4). In the case of the dog in this report, the disease process was advanced and could be diagnosed radiographically and with MRI. Whether the fracture of the IRC bone was a cause or an effect of the AVN could not be determined.

**Discussion**

Avascular necrosis indicates devitalization and bone death from loss of vascularity. The etiology of AVN in humans is a combination of intrinsic and extrinsic factors (5), including acute trauma, chronic repetitive trauma, abnormal loading, morphologic variation, or vascular predisposition/injury (5), and glucocorticoid use, smoking, and vasculitis.

Magnetic resonance imaging is a sensitive and specific test for carpal bone AVN and may allow early disease detection (6). The appearance of AVN on MRI can range from a bone marrow edema pattern with subtle trabecular consolidation to frank subchondral fibrosis and completely devitalized marrow, manifested as low signal intensity on all fluid sensitive pulse sequences. Later stages of AVN may display secondary fracture and collapse.

The lunate and scaphoid are comparable to the mammalian intermediate and radial carpal bones, respectively. In carnivores, the intermediate, radial, and central ossification centers fuse to form the single IRC bone (Figure 3), which is colloquially termed the “radial carpal” bone. Atraumatic carpal AVN in humans has been widely described, with the scaphoid (Preiser’s disease) and lunate (Kienböck’s disease) bones as the 2 most commonly affected (7). Traumatic AVN in humans has been correlated with the unique vascular distribution of the scaphoid, in which the proximal pole is a terminal zone predisposed to vascular compromise. It is uncertain if the canine IRC shares a similar vulnerable vascular pattern. Description of the blood supply to the canine carpal bones is limited, with few anatomic diagrams available (8,9). Gross dissection of the carpus has shown both mid-dorsal and palmarodistal foramen in the IRC bone corresponding with nutrient arteries. The dorsal nutrient artery arises from the dorsal carpal rete, formed from the dorsal carpal branch of the radial artery and a branch of the caudal interosseous artery (8,9). The palmar nutrient artery arises from the deep palmar arch. The internal IRC vascular distribution has not been described. Vascularity likely varies among dogs and additional studies are needed to determine if individual alterations in blood supply to the IRC is a predisposing factor to this condition.

**Figure 1.** Radiographs of the (A) left and (B) right carpus. Notice the collapse of the left intermedioradial carpal (IRC) bone height and dense trabecular pattern (arrows) as well as the soft tissue swelling (*) at the site of prior biopsy.

**Figure 2.** A – Dorsal plane gradient echo magnetic resonance image of the left carpus in the dog of this study, and B – high resolution dorsal plane gradient echo of a normal dog carpus. Note the global loss of signal of the left intermedioradial carpal (IRC – arrows) bone without loss of signal on the articular margins of the adjacent carpal bones. The medial soft tissues are thick (*), attributed to recent biopsy.

**Table 1.** Magnetic resonance imaging acquisition parameters

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<th>Field of view (cm)</th>
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STIR — Short tau inversion recovery; FFE — fast field echo; NA — not applicable.
Human carpal AVN presents with wrist pain, loss of grip and decreased range of motion, but the canine correlate has not been extensively described. Dogs with previously reported IRC and accessory bone AVN were noted to have a poorly defined lameness similar to the dog in this report. The dog in this study had a prolonged lameness that did not respond to NSAIDs and gabapentin. This may be explained as bone pain secondary to ischemia and progressive collapse may not resolve with anti-inflammatory agents particularly if the bone is continually loaded. The canine thoracic limbs are disproportionately loaded during normal ambulation; therefore, even mild activity such as walking could result in sustained microtrauma and pain. Treatment in humans with AVN of the scaphoid or lunate ranges from rest, microfracture drilling, vascular bone grafting, intercarpal fusion, or proximal row carpectomy. The 2 prior cases of canine carpal AVN were treated with arthrodesis, which was successful in resolving pain (1,2). Notably, vascular grafting techniques have been used in canine models of induced AVN of the IRC bone (5,10,11), but have not been incorporated into clinical veterinary protocols. Surgery was not elected in the dog in this report. At a 2-year follow-up, the dog herein had improved with time on NSAIDs. Additional imaging was not elected.

The MRI appearance of experimentally induced AVN in the dog has been described (5), but MRI has not been used to diagnose naturally occurring canine AVN. In previous clinical reports, dogs were diagnosed via biopsy (1,2), which is invasive and may carry associated morbidity in already devitalized bone. The current patient was assessed non-invasively using MRI, the results of which paralleled the findings previously described in the induced canine condition (10), including diffuse edema pattern on fat suppressed images and a substantial signal loss throughout the IRC bone on other pulse sequences. Additional biopsy of devitalized bone may have resulted in further morbidity of the carp bone and/or trauma of regional soft tissues. Biopsy of the small IRC bone was not deemed necessary for the diagnosis in our case report as the diagnosis was typical for the MRI appearance of AVN.

In summary, a cause for suspected IRC AVN in the patient in this report was not determined. This patient was at a later stage of this condition and a fracture was present. The fracture may have been the result of or the cause of the AVN. This patient had no long-term steroid use, systemic inflammatory disease, or other known extrinsic variables. Chronic repetitive trauma was a possibility. In conclusion, MRI is an ideal modality to non-invasively diagnose this condition and should be considered prior to biopsy of areas of potential vascular compromise.

References
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PROGRAM

AAAHT PRE-CONFERENCE CE EVENT
- Zoonoses – Both Sides of the Coin: Dr. Danny Joffe, CARE Centre, Calgary AB. Dr. Mark Joffe, Alberta Health Services, Edmonton, AB
- Practical Techniques in Soft Tissue Surgery - Dr. Howard B Seim III, Department of Surgery, Colorado State University, Fort Collins, CO, USA
- Surgical Oncology – Dr. Bill Dernell, Department of Clinical Sciences, Washington State University, Pullman, WA, USA
- A Practitioners Guide to Managing Problem Behaviours from Kittens to Geriatrics – Dr. Gary Landsberg, North Toronto, Behaviour Specialty Clinic, Thornhill, ON
- Liver and Pancreatic Disease in the Dog and Cat – Dr. David Tweedt, Colorado State University, Fort Collins, CO, USA

COMPANION ANIMAL
- The Veterinarian’s Role in Prescribing and Dispensing - The New Reality – Speakers TBA
- Emerging Diseases in Farm Flocks and Regular Post-Mortem Diseases – Dr. Elise Myers, Technical Services Manager Poultry, Merck Animal Health, Port Franks, ON
- Traceability and Premise Identification – Ms. Katherine Altmann, Alberta Agriculture and Food, Edmonton, AB
- Occurrence, Characterization and Risk Factors Associated with Lameness within Alberta Feedlots Dr. Sonia Marti Rodriguez, Agriculture and Agri-Food Canada Lethbridge Research Centre, Lethbridge, AB
- Clinical Presentations of Lameness in Beef Cattle – Dr. Mike Jelinski, Veterinary Agri-Health Services, Airdrie, AB
- Digital Dermatitis: The New Enemy of Cattle Claws – Dr. Karin Orsel, University of Calgary Faculty of Veterinary Medicine, Calgary, AB
- A Horse’s Life is Not an Easy one: major impediments in good health – Dr. Peter Morresey, Rood and Riddle Equine Hospital, Lexington, KY, USA
- Internal Medicine: Case-based Lab Result Interpretation – Dr. Heidi Banse and Dr. Ashley Whitehead, University of Calgary, Faculty of Veterinary Medicine, Calgary, AB
- Sports Medicine for the Competing Horse – Dr. Kent Allen, Virginia Equine Imaging, Middleburg, VA, USA
- Reconstructive Surgery Techniques – Drs. Aylin Atilla and Terri Schiller, UCVM, Calgary, AB
- Diagnostic Ultrasonography of the Equine Distal Limb – Drs. Mike Scott and Alfredo Romero, UCVM, Calgary, AB
- FAST – The Use of Ultrasound in Trauma and Non-Trauma Critically Ill Patients – Drs. Serge Chalhoub and Soren Boysen, UCVM, Calgary, AB
- Basic Equine Abdominal and Thoracic Ultrasound – Drs. Heidi Banse and Ashley Whitehead, UCVM, Calgary, AB

EQUINE
- The Future of Veterinary Practice - Mr. Stefan Horsky, Associate Veterinary Clinics, Calgary, AB
- Reconstructive Surgery Techniques – Drs. Aylin Atilla and Terri Schiller, UCVM, Calgary, AB
- Diagnostic Ultrasonography of the Equine Distal Limb – Drs. Mike Scott and Alfredo Romero, UCVM, Calgary, AB
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- Basic Equine Abdominal and Thoracic Ultrasound – Drs. Heidi Banse and Ashley Whitehead, UCVM, Calgary, AB

FOOD ANIMAL
- Livestock - Dr. Mike Jelinski, Veterinary Agri-Health Services, Airdrie, AB
- Reducing Animal Stress – Dr. Lisa Radosta, Florida Veterinary Behavior Services, West Palm Beach, FL, USA
- Reputation Management – Mr. Brodie Tyler, Inbound Systems, Meridian, ID, USA
- Livestock - Dr. Mike Jelinski, Veterinary Agri-Health Services, Airdrie, AB
- Reducing Animal Stress – Dr. Lisa Radosta, Florida Veterinary Behavior Services, West Palm Beach, FL, USA
- Reputation Management – Mr. Brodie Tyler, Inbound Systems, Meridian, ID, USA

VETERINARY TEAM
- Dental Workshop for the Veterinary Team: compliance, marketing, growth tools – Mr. Bash Halow, Halow Tassava Consulting, New York, NY, USA
- Fear Free Veterinary Visits: tips for implementation in practice – Dr. Lisa Radosta, Florida Veterinary Behavior Services, West Palm Beach, FL, USA
- Reputation Management – Mr. Brodie Tyler, Inbound Systems, Meridian, ID, USA
- Livestock - Dr. Mike Jelinski, Veterinary Agri-Health Services, Airdrie, AB
- Reducing Animal Stress – Dr. Lisa Radosta, Florida Veterinary Behavior Services, West Palm Beach, FL, USA
- Reputation Management – Mr. Brodie Tyler, Inbound Systems, Meridian, ID, USA

VETERINARY TECHNOLOGISTS
- Introduction to Technical Large Animal Emergency Rescue – Dr. Rebecca Gimenez, Technical Large Animal Emergency Rescue, Macon, GA, USA
- Triage and Azotemia - Dr. Serge Chalhoub and Dr. Soren Boysen, University of Calgary, Faculty of Veterinary Medicine, Calgary, AB

KEYNOTE LUNCHEON
- Introduction to Technical Large Animal Emergency Rescue – Dr. Rebecca Gimenez, Technical Large Animal Emergency Rescue, Macon, GA, USA
- Triage and Azotemia - Dr. Serge Chalhoub and Dr. Soren Boysen, University of Calgary, Faculty of Veterinary Medicine, Calgary, AB

WET LABS, FRIDAY, OCTOBER 14, 2016 (OPEN TO VETERINARIANS ONLY)
- Reconstructive Surgery Techniques – Drs. Aylin Atilla and Terri Schiller, UCVM, Calgary, AB
- Diagnostic Ultrasonography of the Equine Distal Limb – Drs. Mike Scott and Alfredo Romero, UCVM, Calgary, AB
- FAST – The Use of Ultrasound in Trauma and Non-Trauma Critically Ill Patients – Drs. Serge Chalhoub and Soren Boysen, UCVM, Calgary, AB
- Basic Equine Abdominal and Thoracic Ultrasound – Drs. Heidi Banse and Ashley Whitehead, UCVM, Calgary, AB

PROFESSIONALISM – MEDICAL KNOWLEDGE – PRACTICE MANAGEMENT SKILLS
RACE APPROVAL PENDING FOR THE 2016 PROGRAM
Animal Welfare  Bien-être des animaux

Pain in human and non-human animals caused by electricity

Terry L. Whiting

Electricity, as a commodity, is a recent and pervasive technology which is necessary for many aspects of human endeavor including livestock production. In the 1830’s the discovery that a conductor passing through a magnetic field generated an electric current led to a cascade of scientific inquiry and technical developments. Modern intensive livestock production, especially poultry and swine, is possible only with a failsafe electrical power system to provide ventilation, and deliver feed and lighting in temperature-controlled buildings. Lightning, for millennia considered a potentially fatal manifestation of cosmic forces, was demystified by the characterization of static electricity (1,2). Electrical energy can also cause pain when travelling through the human body and may result in thermal injury, and cardiac and respiratory arrest (3,4).

Livestock producers frequently implement new technology or procedures prior to scientific confirmation that the new process achieves the intended outcome. For example, tail docking of dairy cows was widely adopted based on the false belief that it increased cow cleanliness (5). Some countries have responded to this adoption of untested technology as an animal welfare risk by requiring livestock equipment manufacturers to apply for and receive authorization under the national veterinary animal welfare legislation prior to the marketing of novel technology that has the potential to negatively affect livestock welfare (6).

Pain has been used as a method to alter non-human animal behavior since earliest domestication with pain tools such as the ox-goad in biblical narrative (Judges 3:31), and as a symbol of power as the flail and crook (sheep goad) of the Pharaohs. One of the earliest and most widely adopted modern pain technologies of behavioral modification in livestock production is the electric fence. An early application of lethal electric fencing was the border fence between Belgium and The Netherlands during the First World War (7). Pain caused by conducted electricity functions by directly stimulating the efferent axons of the nocireception protective system and is not limited by the specialized pain receptors.

Animal pain has been defined as “an aversive sensory and emotional experience representing awareness by the animal of damage or threat to the integrity of its tissues. It changes the animal’s physiology and behaviour to reduce or avoid the impending tissue damage, to reduce the likelihood of recurrence and to promote recovery” (8). The human or non-human animal responds to pain via everything from protective spinal reflexes to complex affective or avoidance behaviors (9). Normal pain functions to prevent avoidable tissue damage. For “normal” sources of pain such as pressure, heat, cold, puncture, and laceration, animals are equipped with specific receptors in the skin. Pain resulting from modern conducted electrical tools skirts this definition as it is pain not associated with significant tissue damage.

Livestock electric fences are designed to be nonlethal. They consist of low current (amperage) high voltage systems of around 10 000 V (10). The animal experiences an aversive sensation when the body completes the circuit from the live suspended wire to the ground (11). Although the electric current travels through the human body and may result in thermal injury, and cardiac and respiratory arrest (3,4).

Electric livestock fencing, widely adopted in the late 1940’s in North America, included many homemade systems that were occasionally lethal to livestock and humans. Many jurisdictions regulated electric fence manufacture and sale as a public health measure (12). Modern non-lethal electric fence systems are primarily used to contain livestock (13,14) but also effectively exclude wildlife such as white-tailed deer and feral pigs (15,16) and protect bee hives from bear predation (17). The lethal electric fence continues to be applied to contain humans in the prison-industrial complex (18,19).

Cattle quickly learn to avoid the negative experience of contact with a livestock electric fence; often within 24 hours of novel exposure and usually with less than 3 challenges (13,20). Exposure as calves will result in “trained” individuals which will not challenge recognizable electric fences even after over-wintering in conventional buildings (21). The motivation of cattle to not re-experience contact with an electrical fence also allows controlled winter feeding of stored hay or other forage. Cattle will approach the “hot” wire in front of the feed source and reach over or under it to access forage; but, will not touch...
the wire even when strongly motivated by hunger (22). Cattle find electrical shock unpleasant and find increasingly powerful electric shock increasingly unpleasant (23).

Other electrical technology has been developed for the primary purpose of causing pain in human and non-human animals to control behavior. Part of the pain experience (24) results from primary afferent nociceptors, which are a group of specialized cells terminating in the skin, that signal different forms and intensity of pain to the brain (25). Electric shock was widely used in traditional aversive animal behavior studies and standardized as a scientific tool (26). In human psychiatric practice, electric shock has been used as an aversive training tool for mentally affected human animals (27).

The electric "cow trainer" was developed where tie-stall dairy cows were tethered with a chain and soft collar. Housed in long stalls, the tethered cow could back her head out of the manager to lie down. When standing with the head and neck in the manger, body position allowed for manure to fall on the lying area of the cow in the gutter as the building was designed. A cow trainer is a horizontal electrified metal bar that is placed such that when the cow archers her back in positioning for excrement elimination, her dorsal spine at the shoulders will come into contact with the electrified bar (28). The resultant experience of electrical current flow through her body will result in the cow taking a step backward, away from the electrical contact and increase the probability of eliminating in the gutter. In North America, cow trainers were widely adopted in tie stall systems despite evidence that continuing threat of conducted electrical shock would interfere with production (29). Electrified equipment designed to control animal behavior such as the cow trainer may cause welfare problems if not designed, used, and maintained properly (30). The use of electric cow trainers in tie stall barns remains an accepted practice in Canada (31).

Hot-Shot® is a widely distributed brand of electric cattle prod in Canada. The company was started in 1939 in Savage, Minnesota, and was acquired in 2002 by Miller Manufacturing of Glencoe, Minnesota, USA (32). The company claims that in 1939, the Hot-Shot® revolutionized the livestock handling industry as the first commercially available electric livestock prod. The electric cattle prod has become a standard treatment in cattle veterinary procedures, specifically the removal of soft antler (36). The primary trigger for the CVMA concern with electro-immobilization was the growing Canadian cervid industry was using it for the removal of soft antler (49). This year (2016) the position statement on electro-immobilization is up for its 4th renewal. The primary concern at the time of first drafting was the pain associated with this technology (48,49). Although the exact mechanism of action of electro-immobilization was not widely known at the time, veterinary research in the early 1980’s indicated the use of electro-immobilization in non-human animals was severely aversive for the animals so immobilized (50–53). In the past 20 years, electro-immobilization technology has been rejected by the cervid industry itself (54). The CVMA has not adopted a position statement on electric fences, the electric prod or cow trainers.

As the veterinary community was recommending prohibition of electro-immobilization of non-human animals, the police and military industries were investing heavily in research on less-lethal weapons. One innovation was Conducted Energy Weapons (CEW). These weapons are designed to function as a powerful pain device (electric prod) (45,55,56) or to immobilize a person (50). The different outcomes, pain only or pain with immobilization, are a function of how far apart the 2 electric contacts are on the target.

An early commercial CEW, the Taserton, US Patent 3 803 463 in 1974 (TASER® International, Scottsdale, Arizona, USA) was essentially a pain compliance device designed for use on humans. It had fixed contact electrodes less than 10 cm apart (57) delivering local pain without immobilization of the body. To achieve whole body immobilization with a CEW, the electric contact darts need to be far enough apart on the body to create an electronic field that captures a significant volume of skeletal muscle (58). With several decades research in the development, improvement and production of Conducted Energy Weapons there is now a good understanding of the physiology of electro-immobilization in mammals (59–61). Mechanically, “stun
guns” such as the TASER® fire fine wire tethered darts using compressed gas. Ideally the darts will penetrate the skin and fix in the target 40 to 50 cm apart. Skeletal muscle is activated by excitation of the afferent α-motor neurons. The α-motor neurons are very sensitive to electric fields. The majority of skeletal muscle captured in the CEW electrical field is activated indirectly via the motor neuron system (62). When captured in a CEW electric field the α-motor neurons are isolated from dorsal root ganglia moderation and the person experiencing electroimmobilization no longer has voluntary control of her body. Injury subsequent to falling to the ground is a significant risk as the person cannot extend his arms to brace for the fall (57). This risk of injury by uncontrolled fall has been creatively called “gravitational dysreflexia” (63). The intense pain associated with the human experience of CEW results from direct stimulation of the efferent nerves associated with pain detection (9).

The concept of pain in humans is complex with aspects of culture, environment, perception and central processing (64). What an individual non-human animal experiences as pain is unknowable, but presumably is in some way similar to human animal pain. Humans have episodic memory, which refers to the memory of an event as an “episode” and allows individual humans to mentally travel back in time to re-experience an event from the past. Memory of pain, however, appears to be impossible as pain is in “real time”. Although humans may remember the circumstances and unpleasantness of previous painful stimulation, the pain cannot be re-experienced by remembering (65) as positive affective states can be. Attempting to convey the experience of electroimmobilization by humans, one individual describe it as “I never want to go through it again. Trying to convey that sense of pain...is quite difficult” (42).

Electroimmobilization is a remarkably painful experience for the human animal and presumably for non-human animals. In retrospect, it appears that the original CVMA concern and resulting position statement discouraging the use of electroimmobilization of animals was appropriate and useful at the time.

Other uses of pain technologies to modify the behavior of livestock have not been widely discussed within the profession. In a recent attempt to further clarify the concept of “cruelty,” Tanner suggests there are two types of cruelty. Cruelty can be manifest as the commonly imagined sadistic event, where willful pain is caused for another’s enjoyment. However, much more common are situations in which humans are indifferent to the pain of others even when brutal (66). The profession may need to re-examine the use of common pain technologies and review whether the justification is sufficient to maintain their use.

Acknowledgment

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What Can’t Be Taught
Ce qui ne s’enseigne pas

Lessons for the first year in “practice”

Kathryn Welsman

What will your first year be like as a veterinarian? Well I’m sure for everyone it is different but for the sake of sharing, here are some stories from my first year.

I remember thinking it was a bit of a mind trip to go from student to veterinarian. It seemed on one arbitrary day I was given the privilege to be a doctor and I could leave behind the student part. Think how embarrassing it was when I forgot I was the doctor and told one client “the veterinarian will be right in.” This lead to an awkward pause and an even more awkward explanation — I don’t recommend this approach!

In those last few months before graduation, I was very worried about getting out into practice, which was luckily mitigated because at my first job I had a great group of people supporting me. They wanted me to succeed. There was none of the mentality of “I suffered as a new grad, so I will make you suffer too.” The value of mentorship cannot be overstated. I was only at that clinic for a few short months because family life took me west. However, under the guidance of those mentors, I lost some of the newness and got over a few firsts. I remember my first diagnosis; it was a fractured leg, and a pretty obvious one at that, but I still felt a little thrill. Then I wrote my first prescription. Now you might think that seems like a silly thing to remember, but I was full of doubt wondering how would I know what dose, what drug, and for how long to use something. All of a sudden, I had to use my best judgment and clinical experience. When you don’t have much clinical experience that makes things a bit tough. So I thought it was a minor little achievement when I wanted to prescribe metronidazole and I opened up Plumb and had to make a decision. Celebrate your achievements, big or small!

I remember my first disagreement with a fairly intimidating client. He wanted me to falsify a document about his dog’s medical condition. I tried to remember all of my training from the communication classes at OVC and talk my way out of this awkward situation. I wasn’t one to back down from a good argument but when his voice got louder all I wanted to do was write the damn letter and get him out of the building. When I walked out of the examination room, I remember seeing most of the staff standing outside the door with shocked expressions on their faces. I was horrified that I’d caused a scene and probably lost the clinic a client. However, everyone had heard the exchange and the clinic owners were maybe more amused, not angry, that I hadn’t allowed myself to be bullied and done the “right” thing by not writing the letter. I gained confidence knowing I couldn’t be pressured. Going forward though I have learned that it can be very difficult to find that balance between helping a well-meaning client and not compromising your ethics.

When I moved west, I was going to start working at an emergency clinic and I was terrified. Sick to my stomach—want to vomit, kind of terrified. So, in order to prepare myself, I bought Dr. Mathews’ emergency textbook for the drive across the country. While my husband drove, I read. When I drove, he quizzed me on drugs and dosages and protocols. When I showed up for my first shift I wanted to make a good impression. I didn’t want to be the “new” vet all over again. I was doing pretty well until a c-section walked in the door. I started talking to the tech doing the anesthesia and she asked me “how do I like to do c-sections?”, as if I’d done hundreds of them. I was 24 years old and pretty sure I looked it, so I was rather pleased that this seasoned tech had been fooled into thinking I wasn’t a new grad. I burst that bubble pretty quickly when I came right out and said that I’d never done one before. That tech abruptly started to treat me like I was an idiot and from then on I had to work extra hard to show her that I wasn’t! I feared technicians just a little bit after vet school and this seemed to solidify it. I’m sure it isn’t easy for technicians to deal with new veterinarians; so I quickly learned how to work as a team, ask for their input and really value their skills.

The next lesson is one I sincerely hope many of you never learn first hand, let alone in your first year out. I think I was
probably the first in my graduating class to be sued, along with several coworkers. It was an eye opener for sure. It made me realize that good medical records aren't just good medicine but also integral to showing other people you practice good medicine. I felt fearful for a long while about every case I saw, wondering if I was making any mistakes, because to this day, I believe we did everything we could to help the patient in question and yet we were taken to court. I felt shaken because if I was sued over something I did that wasn't wrong, I wondered what could happen if I truly had messed up. I felt shaken because if I was sued over something I did that wasn't wrong, I wondered what could happen if I truly had messed up. I felt fearful for a long while about every case I saw, wondering if I was making any mistakes, because to this day, I believe we did everything we could to help the patient in question and yet we were taken to court. I felt shaken because if I was sued over something I did that wasn't wrong, I wondered what could happen if I truly had messed up. I felt fearful for a long while about every case I saw, wondering if I was making any mistakes, because to this day, I believe we did everything we could to help the patient in question and yet we were taken to court. I felt shaken because if I was sued over something I did that wasn't wrong, I wondered what could happen if I truly had messed up. I felt fearful for a long while about every case I saw, wondering if I was making any mistakes, because to this day, I believe we did everything we could to help the patient in question and yet we were taken to court. I felt shaken because if I was sued over something I did that wasn't wrong, I wondered what could happen if I truly had messed up.

Now on a lighter note, I don't advocate lying or being unethical, but sometimes you might have to be a little discrete about your answers. I remember the day my first solo GDV walked into the building. I knew what to do. I’d done some with other vets and I was ready to tell the client all the pros and cons, all the risks, the costs and so on. What I wasn’t prepared for was this one little question they asked: “how many of these have you done?”...Now I’m hoping they asked that question because I looked like I was 12 and not because I sounded incompetent or inexperienced. In the space of a second I had to decide what the “right” answer to that was. I was rather proud of my answer... “trust me, you don’t want to know”! I wasn’t lying and I wasn’t stressing the owner out unduly. The dog did great and I think I got a nice thank you card for that.

I’ve sweated tons over a bleeding uterus or over chest tube placement but nothing, and I mean nothing, makes me want to run away faster than a euthanasia gone sideways. Nothing can be more uncomfortable and horrifying for the clients and for myself. So if all you remember in your first year out, is to always put your best foot forward when you are helping a beloved pet to the other side. You will get more acknowledgement for euthanasia done well than you will for a major technical surgery. On the flip side, you will also get more complaints and bad press if it doesn’t go well.

Now this last little story, you might want to pay close attention to. I rushed into the office one day in a mild panic about this very ataxic, head bobbing little Chihuahua that was urinating everywhere and I was frantically searching through my neuro notes. The more seasoned vet working that day asked me what I was doing. He listened in a somewhat bored manner then shrugged, turned back to his computer and told me to go back in the room and ask about marijuana use. That stopped me in my tracks. I’m absolutely certain I did not learn how to ask someone if their dog had ingested an illegal substance. Since then I’ve somewhat mastered the technique of “blaming” a walk in the school yard or maybe there could be a “neighbor” who has access! To this day asking clients about marijuana access is still one of the funniest conversations in a really really really awkward way!
Commentary Commentaire

Clinical practice is not mandatory

Bryce I. Fleming

This is a commentary on Dr. Heather Fenton’s article Can Vet J 2016;57:657–658. One of the most valuable qualities of the veterinary profession is the almost limitless spectrum of career options a DVM gives a graduate. When I do a brief survey of my classmates (WCVM ’87) I stand in awe of some of their accomplishments. Among my classmates are numbered an environmental activist, renowned medical researcher, one member of the Order of Canada, a cutting edge veterinary surgeon, and at least one university instructor. I am humbled when I compare my meager efforts over the last thirty years as just another grunt “in the trenches” of general practice. There are times when I agree with the well-known WCVM pathologist who once told me that my very presence in the veterinary college was an insult to the selection process.

In those moments of melancholy, I have to remind myself about my original intent when I entered veterinary college and, indeed, the very thoughts that coursed through my mind as the PhD dressed me down all those years ago: all I ever wanted to be was a general veterinary practitioner working in the field and having the honor of actually directly contributing to my immediate community. Even if I could have qualified, I never aspired to an internship, residency, or specialty qualifications. While everyone around me seemed to believe that advanced degrees indicated superior intellect or skills, I always just saw them as yet another way to avoid actually facing the real world working at a real job.

I realize now that I had a hopelessly biased attitude against academia, but I am still sure that I made the right choice (though I suspect that any instructor who remembers me would agree I really had no choice). There is a true honor in working in general practice and I personally believe that we are all too quick to consider a “lesser” aspiration or “settling.” In fact, I would prefer that our colleges start telling the students the truth: we need durable general practitioners out here in the trenches and prefer that our colleges start telling the students the truth: we need durable general practitioners out here in the trenches.

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I know well the stresses of general mixed practice, having spent nearly twenty years of my career flipping between treating pets and probing the south-end of a north facing bovine, but I never once considered it to be a lesser calling than that of my academically inclined classmates. Perhaps dirtier, longer hours, infinitely colder during the winter and often more dangerous, but never lesser. I enjoyed the fact that I had to adapt to changing conditions on the fly, imagine novel solutions for unique problems and often invent entire new treatments when faced with difficult circumstances and limited resources. I still am proud of the fact that I managed to repair a broken jaw on an elderly stallion that had been turned away by the college as “too high risk.” While my learned colleagues offered euthanasia, I successfully reconstructed the shattered jaw with steel pins, a discarded naso-gastric tube, and plastic cement. That one case encapsulates the true nature of mixed general practice: practical solutions dreamed up in the field on the fly.

Perhaps there are some who criticize the often meager resources available in general practice; certainly I have run into a few practices that are better described as museums rather than modern medical clinics. I remember well using X-ray machines that first saw duty about the time I was starting kindergarten. The problem I have with that generalization is that the majority of modern clinics are on par or even slightly ahead of many of our teaching institutes. As just a small town solo-practitioner I have no less than two ultrasound machines and a full service in-house laboratory. I would happily put any of my ultrasound images beside those captured at any of our Canadian veterinary colleges. Due to amazing Internet data bases such as found at Veterinary Information Network (VIN), most of us general practitioners have access to the cutting edge of modern veterinary medicine, getting exposure to diagnostics and treatments often a decade or more ahead of what is taught in the more conservative “Ivory Tower.” The impression that simple GP veterinarians are backward or outdated is far from modern reality and is just an urban myth created by inexperience.

Thirty years ago, while still a student, I remember butting heads with a senior clinician who would frequently boast how he “knew real practice” because he had done his time in mixed practice prior to entering academia. Even at the time I understood the gross exaggeration of his claims; he had spent a grand total of two years in general practice before scampering back to the protection of his dear Alma Mater. Coming from a family of doctors where I had watched both my elder brothers’ grind through one year of internship followed by multiple years of residency before being able to hang out their shingles as qualified specialists, I understood those two years are just a pebble in the gravel road compared to the entirety of a career. To this day I still hear specialists tell me how they know the rigors of general
practice because they “did one or two years” before deciding to move onto something “more challenging.” The irony of their comments is that they are usually commiserating with me about how challenging they found general practice when they briefly dipped their toes in that deep pool. I am pretty firm in my opinion: you don’t know much at all about general practice if you have only done one or two years out “in the trenches.” In fact, one or two years of general practice has barely scratched the surface in reality since, for much of that time, a new graduate has often been shielded and shored-up by their employer.

I am in the final quarter of my career in general practice now. I now limit my practice to small animals and I have developed a true passion for ultrasound imaging. I fill my free time working part-time for VIN (in a supporting role; God forbid that I would give advice to anyone) and I support a couple of charities that I personally established. I learn something every day and, even now, I still feel like a wet-behind-the-ears newbie from time to time. Rarely a day goes by that I don’t see something that makes me wonder at the marvels of life. Certainly, the 70 to 80 hour work-weeks are starting to wear on me, but the thank-you cards and holiday treats (especially the traditional home-made baklava from Mrs. P. at Christmas) make me remember that I am an integral part of the local community, not just some faceless specialist from down-yonder in the big city. Perhaps I don’t have the alphabet soup after my name and nobody is stepping up to award me any dust-collectors for my mantle, but serving successive generations of families more than makes up for all that.

Choosing a life in general practice is not settling on a lesser career; it is choosing instead to serve the community closest to you; your neighbors and friends, the people who will be there for you when you need them just as you are there when they call. It is with some irony that I recall the angry words of that long ago disappointed college pathologist: I’m still here, still serving and I have not wasted a moment of my career worrying about the internship or residency that I never aspired to. The key to a successful career in general practice is often as simple as really committing to the lifestyle and understanding that the first few years are going to be a bumpy ride. Some of the best destinations lay at the end of a hard road.
The Art of Private Veterinary Practice

Like the rest of society, veterinary education and practice has become increasingly high-tech in the past several decades. Those who attend classes or seminars in which class notes or PowerPoint presentations are available in electronic form beforehand may spend the bulk of their time during the actual event looking at their personal screens. Those of all ages may spend much of their free time scrolling through entries on social media or sending and reading texts on their smart phones. For increasing numbers of practitioners like Dr. Soulange, this has been the norm for most of their lives.

In the practice setting, electronic medical records eliminate the possibility of errors related to Dr. Soulange’s inability to decipher other staff members’ handwriting. It also spares her the time-consuming agony of guaranteeing that her borderline illegible scrawl is legible to others. Like other veterinarians in the facility, she also appreciates the uniform patient history and examination forms that ensure she will not forget anything during these processes. She feels equally confident about her ability to multitask as she enters or peruses her data.

But would her clients agree? Some clients, particularly those as entrenched in electronic media as Dr. Soulange, readily perceive her data entry and processing related to their animals as cutting edge veterinary practice.

“I love that all the vets here can access so much information about Chopin so easily,” explains Mr. Struthers, a client whose geriatric cat has multiple problems. “That’s always reassuring. But it’s especially so in situations where a crisis could occur at any time.”

This client’s highly positive statement is based on several assumptions, one of which is that everything he communicates to the veterinarians during an examination is part of the animal’s electronic record. But whether it is depends on multiple factors.

A critical one is how much attention the clinician actually pays to what the client is saying and any emotional or body language cues that may alter the meaning of those words.

In order to pick up, for example, the slight hesitation that suggests Mr. Struthers may have some reservations regarding his animal’s overall health or treatment, Dr. Soulange and her colleagues either must be looking directly at the client when this information is offered, or have excellent hearing and peripheral vision that enable them to pick up these sometimes subtle cues. If these exist and the practitioners stop and give their clients their full attention and they seek additional information, any client concerns and the veterinarian’s thoughts regarding these will become part of the electronic record. But if the practitioner fails to do this, that information will not be included. While this may not be an issue for many patients, it could be for vulnerable animals with complex or multiple problems.

Mr. Struthers also will be the first to admit that he does not share the same rapport with Dr. Esslinger, another veterinarian in the practice.

“When I volunteer what I consider important information because I don’t want to forget it, Dr. Esslinger acts really put out if it’s not directly related to what she’s asking about or looking at on her screen,” he explains. “If I ask her a question she can’t answer with a ‘yes’ or ‘no’ answer, well, let’s just say I’ve learned not to do that or anything else that might force her to look at me.”

Dr. Esslinger suffers from the combined effect of two communications-related problems. Because she lacks Dr. Soulange’s more out-going personality and self-confidence, she finds it difficult to interact directly with clients. However, unlike practitioners in past generations who had no choice except to develop at least passable communications skills in order to succeed in private practice, she can stare at her computer screen instead. What especially bothers Mr. Struthers about Dr. Esslinger is her obvious annoyance when she must interrupt her data entry to look at him for some reason. Interestingly, even though Mr. Struthers does not like this behavior on her part, it does strongly reinforce his belief that everything he mentions is going into his cat’s medical record. In reality, though, Dr. Esslinger could be missing more than the more relaxed and engaging Dr. Soulange might under those same circumstances.

Avoidance and enhancing screen-based communication

Myrna Milani, DVM

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Multiple studies explore the importance of eye contact for quality communication for everyone from parents interacting with their newborns to executives interacting with potential clients or customers, and all of those who must speak to the public. Dr. Soulange has the ability to periodically establish eye contact in a manner that communicates her genuine interest in her clients without losing her train of thought relative to whatever she is processing electronically. However, Dr. Esslinger does not. She finds that one-on-one communication with clients requires her full concentration. After such interactions, it takes her longer to pull her thoughts together and enter any information related to the client exchange when she turns back to her screen. This further reinforces her aversion to this form of client interaction.

For some clients, direct eye contact with the veterinarian also plays a crucial role in their ability to understand what the clinician is telling them. In our increasingly global society where even the smallest town or city may boast a population of residents for whom English or French is not their first language, lack of eye contact significantly may hinder communication. This occurs because face-to-face interaction makes it much easier for these clients to read the practitioner’s facial expressions and body language, both of which may provide valuable clues regarding the exact meaning of the veterinarian’s words. Sadly, these clients’ sometimes intense gazes in their efforts to glean as much information about their animals as possible may cause practitioners lacking sufficient social and communication skills to retreat to the safety of their screens more than they would with other clients. Aside from using the screen as an escape mechanism potentially undermining the relationship between the veterinarian and the client, this also may result in substandard care for the animal.

But what can practitioners do who find themselves hiding behind their screens some or even most of the time they spend with their clients? In keeping with the old saying, “Forewarned is forearmed,” begin by getting in or back into the habit of reviewing the client-patient history before entering the examination room. Few things communicate disorganization and disregard for the client and animal more than a practitioner trying to play catch-up while they wait.

Additionally, spending the first few minutes actively engaging with the client about any client concerns will help establish or reinforce the practitioner-client relationship. This helps many clients relax which in turn may have a calming effect on their animals. Relaxed clients also are sources of more reliable information. When Dr. Esslinger’s defensive screen use disorients Mr. Struthers, he is much more likely to agree with her to end his discomfort or completely forget what he intended to tell her about his cat’s condition. Relaxed people also retain information better than those who are anxious. While practitioners cannot control everything that may generate anxiety for their clients, they can at least strive to limit or eliminate those that are within their control.

In addition to electronic devices enabling practitioners to maintain all information related to a particular patient in one easily accessible location, these also can be excellent client teaching aids. Something so simple as turning the screen so Mr. Struthers can see the areas of concern on diagnostic images or a comparison of the results of past and recent diagnostic tests as the veterinarian explains these makes him feel like an integral part of the process instead of a mere spectator. Although always important, this is particularly so when the animal has serious or complex problems. Seeing visible evidence of improvement in critical medial parameters may inspire discouraged clients to stay the course. Visible evidence of a downward trend may ease the way to facing the inevitable.

“I know Dr. Soulange’s been trying to tell me Chopin wasn’t going to recover, but I just didn’t want to hear it,” admitted Mr. Struther’s. “But when I saw the changes in the test results and all those tumors growing, I gradually accepted this over time. Once that happened, I was open to some end-of-life discussions with her regarding what I wanted for him and myself. Oddly enough and though he continued to deteriorate, that made it easier for both of us at the end.”

We live in a world in which many people are used to their human healthcare providers interfacing with electronic devices to one degree or another. But although the presence of the same or similar devices in their veterinarian’s clinic or facility might impress them, it probably will not surprise them that much. But as with their physicians, what will concern them is how the presence of that technology will affect their working relationship with the person they rely on to provide quality medical care.
1. **C)** PDA is associated with a continuous left basilar murmur and bounding femoral arterial pulses. The remaining congenital defects are associated with systolic murmurs.

**C)** La persistance du canal artériel est associée au souffle basilaire gauche continu et aux pouls artériels fémoraux bondissants. Les autres défauts congénitaux énumérés sont associés aux souffles systoliques.

2. **D)** Pattern baldness is diagnosed by ruling out endocrinopathies and with skin biopsy. It is a nonpruritic condition; the other choices are diagnostic tests for pruritic conditions.

**D)** L’alopécie est diagnostiquée en éliminant les endocrinopathies par biopsie de la peau. La condition présentée est non prurigineuse; les autres choix énumérés sont des épreuves diagnostiques pour des problèmes prurigineux.

3. **C)** Clinical signs are strongly suggestive of hyperthyroidism. This may be a case of occult hyperthyroidism. However, the clinical signs of hyperthyroidism can be seen in association with other conditions. A tri-iodothyronine (T3) suppression test would be useful to help with the diagnosis. Methimazole should not be started until a definitive diagnosis has been made.

**C)** Les signes cliniques suggèrent fortement de l’hyperthyroïdisme. Il peut s’agir d’un cas d’hyperthyroïdisme occulte. Toutefois, les signes cliniques d’hyperthyroïdisme peuvent être observés en association avec d’autres affections. Un test de suppression à la tri-iodothyroxine (T3) pourrait être utile pour aider au diagnostic. On ne doit pas débuter de traitement au méthimazole avant la confirmation d’un diagnostic définitif.

4. **A)** Clinical signs of hypothyroidism in adult horses include lethargy, poor exercise tolerance, muscular problems, increased sensitivity to cold temperatures, delayed shedding of hair, and a coarse, thickened face.

**A)** Les signes cliniques d’hypothyroïdisme chez les chevaux adultes comprennent la léthargie, l’intolérance à l’effort, les problèmes musculaires, l’augmentation de la sensibilité aux températures froides, le retard de la mue et l’épaississement de la face.

5. **E)** Although all can cause subcutaneous emphysema, escape of intraperitoneal free air after a standing flank laparotomy is common if the peritoneal closure is imperfect. It presents with no other signs, and usually resolves without complications.

**E)** Bien que toutes les affections énumérées puissent causer de l’emphysème sous-cutané, l’échappement de l’air libre intrapéritonéal à la suite d’une laparotomie par le flanc en position debout est fréquent si la fermeture du péritoine est imparfaite. Il n’y a pas d’autres signes, et usually resolves without complications.
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