The Canadian Veterinary Journal
La Revue vétérinaire canadienne

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1. Toutain C, Seewald T, Jung M. Pharmacokinetics of lotilaner following a single oral or intravenous administration in cats. Parasite Vector. 2018;11:412
2. Chappell K, Paarlberg T, Seewald W, et al. A randomized, controlled field study to assess the efficacy and safety of lotilaner flavored chewable tablets (Credelio® Cat) in eliminating fleas in client-owned cats in the USA. Parasite Vector. 2021;14:127
3. Credelio Cat Product label

*72 hours after administration or infestation throughout the month.

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President's Message
Le mot du président

Do you remember "Why"?
Se rappeler le « pourquoi »

Do you remember *the moment* you received your acceptance to vet school? Maybe the moment you donned your Blue Coat, or when your first White Coat was placed over your shoulders?

Welcome, Doctor of Veterinary Medicine! You will do great things!

I do. It still stirs a passion and pride in me like it did back then. I love our profession, but I am filled with worry. I see cracks in strong and competent people, friends, and colleagues just like you.

Do you remember that "feeling" — the hope, excitement, opportunity?

What about the "why" we do what we do, no matter which path in veterinary medicine you have taken?

We know the privilege we have being veterinarians comes with the expectation and responsibility of service to society, and it can come at a deep individual cost. Right now, the veterinary profession is strained to an extent we have never experienced before.

Perhaps, like me, you've been around awhile, and you aren't "feeling" our profession like you used to. Or perhaps you are a student or new veterinarian who is overwhelmed, and you feel like the path you have devoted so much of your life to isn't quite feeling like you expected. I implore each of you to return to your roots, to remember your "why" and that feeling you had when you received that acceptance letter or first donned your Blue Coat, the moment you walked across the stage to become a DVM!

We all know that not every day will give you that feeling, and if I'm being honest, I've experienced some painful lows — the kind that shook my confidence, stole my appetite for weeks, and made me feel like I couldn't breathe. These moments stole my desire and made me question my love of veterinary medicine and my own self-worth.

Those who I'm closest to know this. They watched helplessly and offered what support they could. They also know how difficult it is for me to write these words here, as I am by nature very private.

Vous souvenez-vous du *moment précis* où vous avez reçu la réponse à votre demande d'admission en médecine vétérinaire? Ou encore du moment où vous avez revêtu un sarrau ou une tenue chirurgicale pour la première fois?

Ce moment qui semblait vous dire bienvenue dans le monde de la médecine vétérinaire, vous accomplirez de grandes choses!

Moi, je m'en souviens. Le souvenir de ce moment éveille en moi autant de passion et de fierté que lorsque je l'ai vécu à l'époque. J'adore ma profession, mais je suis inquiet. Je perçois de la souffrance chez plusieurs personnes fortes et compétentes, des amis, et des collègues comme vous.

Vous souvenez-vous du sentiment spécial qui vous a envahi, un mélange d'espoir et d'excitation à l'idée de toutes les possibilités qui s'offraient à vous?

Qu'en est-il du « pourquoi » vous faites ce que vous faites, peu importe le chemin que vous avez décidé de prendre en médecine vétérinaire?

Nous savons que le privilège que nous avons en tant que vétérinaires vient avec des attentes et la responsabilité de servir la société, et parfois un coût important sur le plan personnel. À l'heure actuelle, la profession vétérinaire est mise à l'épreuve comme jamais auparavant.

Peut-être que vous pratiquez depuis un certain temps comme moi et que votre regard sur la profession a changé. Ou peut-être êtes-vous encore aux études ou en début de carrière et vous constatez que la voie à laquelle vous avez consacré autant d'efforts ne ressemble pas vraiment à ce à quoi vous vous attendiez. Je vous invite tous à vous souvenir de votre « pourquoi » et du sentiment qui vous habitait quand vous avez reçu votre lettre d'admission, quand vous avez enfilé votre sarrau pour la première fois, ou quand vous étiez sur la scène pour recevoir votre diplôme de D.M.V. tant convoité!

Nous savons tous que nous ne ressentirons pas ce même sentiment tous les jours. J'ai moi-même connu des périodes creuses plutôt douloureuses. Elles ont ébranlé ma confiance et volé mon appétit pendant des semaines, et elles m'ont donné l'impression de ne plus pouvoir respirer. Ces moments ont

That feeling, your pride and excitement, was deserved and so real, and you deserve it again. So, how do you find your way back there?

You might wonder how I have navigated those incredibly difficult days, what was it that allowed me the courage to believe in myself again so that I found my way back.

If I can distill it down to a single thing after travelling more than a million kilometers around rural Nova Scotia, there is one thing that has protected me, healed me, allowed me to love my profession again — it has been the many deep ***relationships*** that I've forged over the last 20 years serving clients who cared about me as much as I did about them.

It has also been the many incredibly deep and supportive ***relationships*** I have with colleagues from across our profession — the ones who believed in me when I donned my Blue Coat, those who encouraged me at every turn on my journey, and those that knew how to help pick me up when I was failing. All of them have at times helped me rewrite a heavy and dangerous narrative of negativity that can creep into all of us.

I remember the first time a client asked me, "Trevor, are you OK?" moments after we said farewell to a lifelong friend; it was many years ago. "George" was a beautiful chestnut gelding, and I knew how incredibly deep their bond was. I'm certain George's person didn't know the power of that moment when she laid her hand on my shoulder and spoke such genuine words. I've replayed that moment, and many like it, over the years — all those people who have cared as much as I have. A global pandemic may have disrupted those moments, but to be honest, I made a choice to keep some of those moments despite COVID-19. This likely didn't make me the best at adhering to public health guidance at times, but I chose another wellness and health path: togetherness and connection.

If we want the most out of life, the most from our profession, it is going to depend on relationships, togetherness, and connections that will carry us on the darkest days. To do this, there is something that is necessary: Allow yourself to be truly vulnerable without knowing what might come next. The gifts that will follow will sustain you when you are tired, injured, and need strength, and they'll remind you of your "why."

These relationships, along with the Canadian Veterinary Medical Association's and our provincial associations' slate of programs, can help you through the most challenging period our profession has ever known. ■

Trevor Lawson

étouffé ma passion, remis en doute mon amour de la médecine vétérinaire, et affecté mon estime personnelle.

Mes proches en ont été témoins – ils se sentaient impuissants et ont tenté de me soutenir de leur mieux. Ces gens savent aussi combien il m'est difficile d'écrire ces mots, car je suis une personne plutôt réservée.

Ce sentiment de fierté et de motivation était si fort, et vous méritez de le ressentir à nouveau. Comment pouvez-vous le retrouver?

Vous vous demandez peut-être comment j'ai réussi à traverser cette période difficile et ce qui m'a donné le courage de croire à nouveau en moi pour retrouver le feu sacré.

Je crois que ce qui m'a protégé, guéri et permis d'aimer à nouveau ma profession en parcourant plus d'un million de kilomètres dans les régions rurales de la Nouvelle-Écosse, ce sont les nombreuses et profondes ***relations*** que j'ai nouées au cours des vingt dernières années à servir des clients qui s'intéressaient à moi autant que je m'intéressais à eux.

Ce sont aussi les ***relations*** solides et solidaires que j'ai tissées avec des collègues de toute la profession – ceux qui ont cru en moi lorsque j'ai revêtu mon sarrau, ceux qui m'ont encouragé à chaque étape de mon parcours, et ceux qui ont su m'aider à me relever lorsque j'en ai eu besoin. Toutes ces personnes m'ont aidé à chasser la spirale de négativité qui peut s'infiltrer en chacun de nous.

Je me souviens de la première fois qu'une cliente m'a demandé : « Trevor, est-ce que ça va? », quelques minutes après avoir dit adieu à son compagnon de longue date; c'était il y a plusieurs années. « George » était un magnifique hongre alezan, et je savais à quel point le lien qui les unissait était spécial et fort. Je suis certain que la propriétaire de George n'était pas consciente du pouvoir de ce moment où elle a posé sa main sur mon épaule et a prononcé ces mots. Je me suis souvent remémoré cet événement, et plusieurs autres au fil des ans, ainsi que tous ces gens bienveillants. Une pandémie mondiale a peut-être perturbé ces moments, mais pour être honnête, j'ai décidé d'en garder quelques-uns malgré la COVID-19 – cela n'a probablement pas fait de moi le champion de l'adhésion aux consignes de santé publique dans certains cas, mais j'ai choisi une autre voie favorisant le bien-être et la santé, soit celle de la fraternité et de la connexion.

Si nous voulons tirer le meilleur parti de la vie et de notre profession, notre capacité à le faire dépendra des relations, de la solidarité et des liens qui nous porteront durant les jours les plus sombres. Pour y arriver, il faut s'autoriser à être vraiment vulnérable sans savoir ce qui nous attend ensuite. Les cadeaux qui suivront vous soutiendront lorsque vous serez fatigués, blessés et que vous aurez besoin de force, et ils vous rappelleront votre « pourquoi ».

Ces relations, ainsi que les divers programmes de l'Association canadienne des médecins vétérinaires et des associations provinciales, pourront vous aider à traverser la période la plus difficile que notre profession ait jamais connue. ■

Trevor Lawson

RECENT STUDIES FOUND THAT 95% OF CATS AND 85% OF DOGS HAD BEHAVIOURAL PROBLEMS.[1,2]

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Veterinary Medical Ethics
Déontologie vétérinaire

Ethical question of the month — June 2023

As a veterinarian working for a nonprofit that provides support to both people and their pets, I often encounter situations where people with low or no income are looked down upon for not relinquishing their pet. Specifically, I have seen situations where people who are experiencing homelessness or are seeking help to escape domestic violence struggle to keep their pet. **If we assert that pet ownership is a privilege, are we denying the benefits of this relationship to entire groups of people who are frequently marginalized because of the social and economic inequalities in society?**

Question de déontologie du mois – Juin 2023

En tant que vétérinaire travaillant pour un organisme à but non lucratif qui aide les gens et leurs animaux, je suis souvent témoin de situations où des personnes à faible revenu ou sans revenu sont traitées avec mépris parce qu'elles refusent d'abandonner leur animal de compagnie. Par exemple, j'ai vu des personnes sans domicile fixe ou victimes de violence familiale être confrontées à des choix déchirants pour pouvoir garder leur animal. **Si nous affirmons que la possession d'un animal est un privilège, est-ce que nous privons des groupes entiers de personnes, souvent marginalisées en raison d'inégalités sociales et économiques dans la société, des bienfaits d'une relation avec un animal de compagnie?**

Attitudes towards pet ownership among marginalized people — A comment

The assertion that pet ownership is a privilege not only damages the human-animal bond but also legitimizes maintenance of the *status quo* in veterinary service that excludes a considerable portion of the population from accessing care. As health professionals and stewards of One Health, veterinary professionals need to consider how we can contribute to the fostering and maintenance of pet-human bonds within and outside of our familiar clinic environments.

Submitted by Canadian Collective for Equity in Veterinary Medicine

Ethicists' commentary on attitudes towards pet ownership among people experiencing homelessness

This case raises several important and interesting ethical concerns about appropriate attitudes and practices towards those who are marginalized in society — especially those who are experiencing homelessness. Given space limitations, we'll focus here on just 2 questions. 1) Are there any specific ethical issues that experiencing homelessness raises in the context of keeping companion animals? 2) What kinds of obligations might veterinary professionals have towards people in this situation and to their animals?

The main worry raised by question 1) concerns *welfare*. There is considerable evidence that keeping animal companions can be good for the welfare of the *humans* concerned, often providing a meaningful, stable relationship even when other relationships are failing. This seems to be a reason why many homeless individuals keep animal companions — but what about the *animals*' welfare? Might a dog, for instance, need a single, secure residence, or a large, fenced yard, for good welfare?

Research on this topic (both in Canada and elsewhere) doesn't support the idea that the welfare of dogs owned by people experiencing homelessness is worse than that of dogs owned by people who have a home. Indeed, some evidence suggests the opposite. One study estimates that the animal companions of people experiencing homelessness enjoy ~3 times as much playtime and exercise as the companions of those people with homes. This increased exercise and human contact may explain why, typically, compared to those with a traditional home, these animals enjoy better body conditions, lower rates of obesity, and fewer behavioral problems, including aggression towards strangers.

It's true that, in some cases, mental illness and substance abuse may render individuals unable to care well for their animal companions. However, such issues may arise whether or not someone has a home. Overall, evidence suggests that people experiencing homelessness can, in most cases, maintain a good

life for their companions, providing benefits to both humans and animals. On this basis there is certainly no reason for these individuals to be "looked down upon for not relinquishing their pet." Indeed, turning to question 2), we suggest that there is a positive responsibility for veterinarians and others to interact with these people without prejudices and to help fight the stereotypes they face. Veterinarians can also help homeless owners of dogs and other companion animals by collaborating in various ways with the relevant NGOs.

Indeed, this month's question illustrates the value of adopting a One Health perspective. The Canadian Veterinary Medical Association has a One Health policy stating "Veterinarians are 'One Health' practitioners, protecting the health and safety of animals, which in turn, helps to protect people and the environment." We encourage the veterinary community in Canada to apply this policy to the issue at hand by leading conversations around marginalized people and their animal companions, highlighting that these relationships will, in most cases, benefit the welfare of both these people and the animals for which they care.

Drs. Clare Palmer, Peter Sandøe, and Dan Weary

Ethical question of the month – September 2023

I recently had to make a difficult decision about my beloved, 1-year-old cat. She had some behaviors, respiratory issues, and urinary disease that were challenging to manage. One of the recommendations was that she live in a low-stress home with no other pets. Discussion with my colleagues at the BC SPCA led to the conclusion that she would be nearly impossible to rehome successfully, especially given the current capacity issues in shelters and rescues. We made the heartbreaking decision to have her euthanized. We chose to have this done ourselves, to minimize her stress, rather than to return her to the shelter. On arrival at the clinic, the veterinarian refused to perform the euthanasia. A technician told us that they "feel more could be done for this young cat," and said that if we wanted to talk to the veterinarian directly, we would be charged an "exam fee." I am not convinced that the veterinarian was aware of the cat's full history, since the discussion with the technician had been brief. Distraught, we left. I understand that euthanasia can be difficult for veterinarians and staff. Requesting euthanasia is rarely an easy decision. **Is it reasonable that veterinarians must consider the consequences that refusing euthanasia would have for the animal, their family, and community resources such as shelters? Should veterinarians carefully weigh the owner's motives and knowledge before declining euthanasia?**

Question de déontologie du mois – Septembre 2023

J'ai récemment dû prendre une décision difficile au sujet de ma chatte adorée, âgée d'un an. Elle avait des problèmes comportementaux, respiratoires et urinaires difficiles à prendre en charge. L'une des recommandations était qu'elle vive dans une maison offrant un environnement peu stressant, sans cohabitation avec d'autres animaux. J'en ai discuté avec mes collègues de la SPCA de la Colombie-Britannique, et nous avons conclu que ce serait pratiquement impossible de la faire adopter avec succès, compte tenu notamment des problèmes de capacité des refuges. J'ai pris la décision déchirante de la faire euthanasier. J'ai choisi de la faire euthanasier moi-même plutôt que de la ramener au refuge pour réduire le plus possible son stress. À mon arrivée à la clinique, le vétérinaire a refusé l'euthanasie. Une technicienne m'a dit que le vétérinaire estimait qu'il y avait d'autres options pour ce jeune animal, et que si nous voulions lui parler directement, nous aurions des « frais d'examen » à payer. Je ne crois pas que le vétérinaire était au courant de l'historique complet de la chatte, car la discussion avec la technicienne avait été brève. Désemparé, je suis parti. Je comprends que l'euthanasie peut être difficile pour les médecins vétérinaires et le personnel, mais se résoudre à l'euthanasie est rarement une décision facile à prendre. **Serait-il raisonnable que les médecins vétérinaires tiennent compte des conséquences possibles du refus de l'euthanasie pour l'animal, sa famille et les ressources communautaires comme les refuges? Devraient-ils évaluer soigneusement les motivations et les connaissances du propriétaire avant de refuser l'euthanasie?**

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 Canadian Veterinary Medical Association, Attn: Journals Department, 339 Booth Street, Ottawa, Ontario K1R 7K1; email (bettinadvm@gmail.com). A longer response may appear as a Letter to the Editor.**

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 avec vos nom et adresse **par la poste (Choix déontologiques, Association canadienne des médecins vétérinaires, À l'attention de : Journals Department, 339 rue Booth, Ottawa, Ontario, K1R 7K1) ou par courriel (bettinadvm@gmail.com). Les réponses plus longues pourraient être publiées dans le courrier des lecteurs.**

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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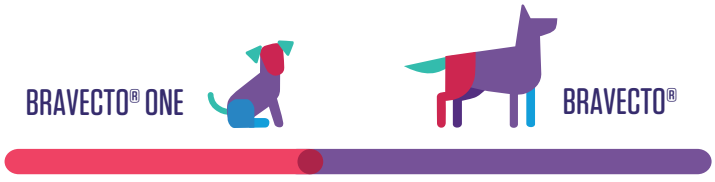

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Quiz Corner
Test éclair

1. A 2-year-old neutered male domestic shorthair cat is brought to your clinic because of profound lethargy and collapse. A complete blood (cell) count (CBC) reveals severe anemia due to flea infestation and *Mycoplasma haemofelis* infection.

You start a packed red blood cell transfusion (the cat is blood type A). After 1 h, the cat vomits. Test parameters from before and during the transfusion are shown below.

What is the most appropriate action?

A. Administer broad-spectrum antimicrobials
B. Discontinue transfusion
C. IV bolus of balanced crystalloids
D. Give parenteral dexamethasone
E. Proceed with blood administration at a decreased rate

1. Un chat domestique à poil court castré de 2 ans est amené à votre clinique en raison d'une léthargie importante et d'un collapsus. L'hématologie révèle une anémie marquée due à une infestation par des puces et à une infection par *Mycoplasma haemofelis*.

Vous commencez la transfusion d'un concentré de globules rouges (le groupe sanguin du chat est A). Après une heure, le chat vomit. Les résultats des tests effectués avant et pendant la transfusion sont présentés ci-dessous.

Quelle est l'action la plus appropriée?

A. Administrer des antimicrobiens à large spectre d'action
B. Interrompre la transfusion
C. Donner un bolus IV de cristalloïdes équilibrés
D. Donner de la dexaméthasone par voie parentérale
E. Poursuivre la transfusion en réduisant le débit

Test Paramètre	Pre-transfusion Avant la transfusion	Mid-transfusion Durant la transfusion	Reference Valeurs de référence
Temperature Température	39.3°C (102.8°F) 39,3 °C (102,8 °F)	40.1°C (104.2°F) 40,1 °C (104,2 °F)	37.8–39.5°C (100–103.1°F) 37,8-39,5 °C (100-103,1 °F)
Heart rate Fréquence cardiaque	234 beats/min 234 battements/min	226 beats/min 226 battements/min	180–220 beats/min 180-220 battements/min
Respiratory rate Fréquence respiratoire	32 breaths/min 32 respirations/min	34 breaths/min 34 respirations/min	16–40 breaths/min 16-40 respirations/min

2. You examine a 19-year-old thoroughbred gelding with a 48-hour history of cough.

The owner says the horse coughs frequently during feeding when he eats hay, but notes this is the only time she has been in the barn recently to observe the horse.

The horse has a small amount of bilateral mucoid nasal discharge and is breathing heavily, especially when he exhales. The mucous membranes are pink. Expiratory wheezes are audible during thoracic auscultation.

Results from physical examination and hematology testing are shown below.

Test Paramètre	Value Résultat	Reference Valeurs de référence
Temperature Température	37.8°C (100°F) 37,8 °C (100 °F)	37.2–38.1°C (99.0–100.6°F) 37,2-38,1 °C (99,0-100,6 °F)
Heart rate Fréquence cardiaque	36 beats/min 36 battements/min	28–40 beats/min 28-40 battements/min
Respiratory rate Fréquence respiratoire	24 breaths/min 24 respirations/min	10–14 breaths/min 10-14 respirations/min

Equine hematology/Hématologie équine

Test Paramètre	Value Résultat	Reference Valeurs de référence
RBC/Érythrocytes	7.25	6.30–10.90 M/μL
Hematocrit/Hématocrite	30.9	32.5–46.5%
Hemoglobin/Hémoglobine	10.6	11.4–17.3 g/dL
MCV/VGM	43	39–55 fL
MCH/TCMH	14.6	14.6–19.1 pg
MCHC/CCMH	34.3	33.6–38.6 g/dL
WBC/Leucocytes	6.2	4.3–11.4 K/μL
Neutrophils/Neutrophiles	2.96	2.46–7.23 K/μL
Lymphocytes	2.06	1.45–5 K/μL
Monocytes	1.13	0–0.6 K/μL
Eosinophils/Éosinophiles	0.03	0–0.7 K/μL
Basophils/Basophiles	0.02	0–0.1 K/μL
Platelets/Plaquettes	191	70–250 K/μL
Fibrinogen/Fibrinogène	400	100–400 mg/dL
SAA	25	0–10 ng/mL

Which of the following diagnostic findings would confirm the top differential diagnosis?

A. Transtracheal wash reveals numerous eosinophils
B. Neutrophilia on bronchoalveolar lavage cytology
C. Thoracic radiographs show interstitial pattern
D. Demonstration of tracheal mucus on airway endoscopy
E. Consolidated lung seen on thoracic ultrasound

The questions and answers are provided by The Zuku Review, online veterinary test prep.

Les questions et les réponses sont gracieusement fournies par le site de préparation aux examens vétérinaires Zuku Review.

2. Vous examinez un hongre Thoroughbred de 19 ans qui présente de la toux depuis 48 heures.

La propriétaire dit que le cheval tousse souvent quand il mange du foin, mais elle précise que ce n'est qu'à l'heure des repas qu'elle est allée dans l'écurie récemment pour observer le cheval.

Le cheval a un léger écoulement nasal mucoïde bilatéral et il respire bruyamment, surtout à l'expiration. Ses muqueuses sont roses. Des sifflements expiratoires sont audibles à l'auscultation thoracique.

Les résultats de l'examen physique et du bilan sanguin sont présentés ci-dessous.

Equine blood chemistry/Biochimie équine

Test Paramètre	Value Résultat	Reference Valeurs de référence
Glucose	112	49–102 mg/dL
Creatinine/Créatinine	0.8	0.8–1.8 mg/dL
IDEXX SDMA/SDMA IDEXX	7	0–14 μg/dL
BUN/Urée	14	11–25 mg/dL
Phosphorus/Phosphore	3.5	2.0–4.8 mg/dL
Calcium	11.2	10.2–12.8 mg/dL
Sodium	134	132–141 mmol/L
Potassium	4.4	2.5–5.2 mmol/L
Chloride/Chlorure	102	96–106 mmol/L
TCO_2 (bicarbonate)	20	21–31 mmol/L
Anion gap/Trou anionique	16	11–26 mmol/L
Total protein/Protéines totales	6.4	5.5–7.5 g/dL
Albumin/Albumine	3.6	3.0–3.9 g/dL
Globulin/Globulines	2.4	2.3–4.1 g/dL
Albumin:globulin ratio Rapport albumine/globulines	1.5	0.8–1.6
AST	305	194–431 U/L
ALP	93	76–262 U/L
GGT	13	9–37 U/L
Bilirubin — total/Bilirubine totale	1.1	0.4–2.8 mg/dL
Bilirubin — unconjugated Bilirubine non conjuguée	0.8	0.1–2.8 mg/dL
Bilirubin — conjugated Bilirubine conjuguée	0.3	0.2–0.6 mg/dL
Cholesterol/Cholestérol	75	49–150 mg/dL
Creatine kinase/Créatine kinase	165	130–497 U/L

Parmi les résultats suivants, lequel confirmerait le principal diagnostic différentiel?

A. Le lavage transtrachéal révèle de nombreux éosinophiles.
B. La cytologie du lavage bronchoalvéolaire révèle une neutrophilie.
C. Les radiographies thoraciques montrent un patron interstitiel.
D. L'endoscopie des voies respiratoires révèle la présence de mucus dans la trachée.
E. Du tissu pulmonaire consolidé est visible à l'échographie thoracique.

(See p. 878 for answers./Voir les réponses à la page 878.)

Future Veterinarian Support Continues from Scotiabank, a Preferred Partner of the Canadian Veterinarian Medical Association (CVMA)

Scotiabank is proud of the continued support of *The Canadian Veterinary Journal (The CVJ)* in keeping students informed about the industry throughout their studies. Since 2015, Scotiabank has supported the program, offering veterinary students across Canada a complimentary subscription of *The CVJ*.

Scotiabank understands the importance of staying informed about current issues and topics for professionals within the veterinary community nationally. Scotiabank is extremely committed to supporting the veterinary community and contributes by providing access to these journals for the nation's future veterinarians.

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For more information about Scotiabank's services for professional students, please visit (scotiabank.com/veterinarians) or speak with a Scotiabank Advisor today.

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La Banque Scotia, partenaire privilégié de l'Association canadienne des médecins vétérinaires (ACMV), continue d'appuyer les futurs vétérinaires

La Banque Scotia est fière de continuer à appuyer les efforts de *La Revue vétérinaire canadienne* (*La RVC*) visant à informer les étudiants de ce qui se passe dans l'industrie pendant leurs études. Depuis 2015, la Banque Scotia soutient le programme en offrant aux étudiants en médecine vétérinaire de partout au Canada un abonnement à *La RVC* sans frais.

La Banque Scotia comprend l'importance d'être au courant des enjeux et des sujets d'actualité pour la communauté vétérinaire dans l'ensemble du Canada. Dans le cadre de son engagement envers les professionnels vétérinaires, la Banque Scotia trouve important de donner accès à *La RVC* aux futurs vétérinaires du pays.

Les études vétérinaires peuvent être difficiles, mais les finances personnelles n'ont pas à l'être. En tant que fournisseur privilégié de services financiers de l'ACMV, la Banque Scotia a conçu le programme Professions libérales Scotia pour étudiants afin de répondre aux besoins et objectifs uniques des étudiants en médecine vétérinaire, notamment par le financement des études et l'accès à certaines cartes de crédit haut de gamme. Pour les professionnels en pratique, le programme Professions libérales Scotia offre tout ce dont les médecins vétérinaires ont besoin pour réussir financièrement, tant sur le plan personnel que professionnel.

De l'assistance et des ressources supplémentaires sont fournies aux étudiants en médecine vétérinaire du Canada dans le cadre du programme des représentants de la Banque Scotia, qui fait en sorte qu'un conseiller dédié est affecté aux besoins des étudiants en médecine vétérinaire de chaque université. Les représentants de la Banque Scotia pour chaque école vétérinaire canadienne sont listés ci-dessous. La Banque Scotia remercie les représentants étudiants de l'ACMV qui distribuent *La RVC* sur le campus.

Pour en savoir plus sur les services offerts par la Banque Scotia aux étudiants en médecine vétérinaire, visitez le site Web de la Banque Scotia (https://www.scotiabank.com/ca/fr/commercial-banking/professionnels/veterinaires.html) ou parlez avec un conseiller de la Banque Scotia dès aujourd'hui.

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	Shelley Wilson	shelley.wilson@scotiabank.com	902-802-4296

A Year in Review 2022–2023

The big news in 2022–2023 was that every veterinary medicine faculty across Canada resumed all academic and social activities. Student clubs organized countless conferences and numerous labs and workshops for students, and every faculty event that took place before the pandemic was back on the school calendar.

For the Students of the Canadian Veterinary Medical Association (SCVMA), the year started with organizing the ceremonies for handing out lab coats, which participants attended in person. In preparation for their clinical year, the lab coats were generously donated by the CVMA, as were the personalized badges.

The One Voice presentations were also attended in person. Each of the 5 veterinary schools across Canada organized a conference, with their own speakers, on a common theme selected

Adalaïs Gibert

Bilan de l'année 2022-2023

L'année 2022-2023 a été marquée par le retour complet des activités académiques et sociales dans toutes les facultés de médecine vétérinaire canadiennes. Les clubs étudiants ont organisé d'innombrables conférences et de nombreux laboratoires et ateliers pratiques pour les étudiants, et tous les évènements facultaires qui avaient lieu avant la pandémie ont retrouvé leur place dans le calendrier de l'année scolaire.

Au Comité étudiant de l'ACMV (CEACMV), l'année a tout d'abord débuté avec l'organisation des cérémonies de remise des sarraus qui s'est tenue en personne. En vue de leur année clinique, les étudiants ont pu recevoir leur sarrau généreusement offert par l'ACMV ainsi que leur badge personnalisé.

Cette année, les présentations « Une voix » ont également pu avoir lieu en personne. Dans chacune des cinq écoles vétérinaires canadiennes, une conférence distincte a été organisée sur un thème commun choisi par les représentants de l'année précédente. Le sujet de discussion qui avait été choisi était « Faire face à l'échec ». Pour la Faculté de médecine vétérinaire (FMV), le repas fourni lors de la conférence était la fameuse poutine québécoise, ce qui a évidemment beaucoup plu aux étudiants, et a apporté le réconfort nécessaire pour aborder un sujet difficile, mais tellement important, soit l'échec comme partie inévitable de l'apprentissage.

Du 19 au 21 janvier 2023, le Symposium du CEACMV s'est tenu à l'Île-du-Prince Édouard. L'Atlantic Veterinary College a ainsi accueilli, sous la coordination de **Lindsay Gallant** et de son équipe de bénévoles, des étudiants vétérinaires provenant des quatre autres écoles canadiennes. Cela a marqué le grand retour du Symposium en personne après deux années en ligne. Ce fut une très belle fin de semaine et j'attends avec impatience le Symposium de 2024, qui sera organisé par la nouvelle représentante séniore de la FMV, **Alice Cheng**. Je vous encourage fortement à y participer au moins une fois dans votre parcours en médecine vétérinaire!

Le CEACMV a durement travaillé cette année pour donner plus de visibilité à l'ACMV au sein des facultés respectives de ses représentants. À la FMV, une des initiatives fut d'organiser un atelier d'associations, où toutes les associations professionnelles

by the previous year's representatives. This year's chosen topic was "Coping with failure." La Faculté de médecine Vétérinaire (FMV) opted to serve Quebec's famous poutine at the conference, which naturally was very well received by the students and provided the kind of comfort food that helped address a difficult — but extremely important — topic of how failure is an inevitable part of learning.

From January 19–21, 2023, the SCVMA Symposium was in Prince Edward Island. The Atlantic Veterinary College hosted veterinary students from the other 4 Canadian schools, under the coordination of **Lindsay Gallant** and her team of volunteers. This marked the return of personal attendance at the Symposium after 2 years of being held virtually. It was a beautiful weekend, and I can't wait for the 2024 Symposium, which will be organized by the new senior FMV representative, **Alice Cheng.** I strongly encourage you to take part at least once during your veterinary studies!

The SCVMA worked hard this year to provide more visibility to the CVMA in its representatives' respective faculties. At the FVM, one of the initiatives was an associations workshop, where all the provincial professional associations had the chance to introduce themselves to FMV's student community. Needless to say, the CVMA was invited. The Quebec representative on the CVMA Council, **Dr. Jordyn Hewer,** had the opportunity to speak directly with the students and to tell them about the CVMA's mandate and roles during their studies and later in their careers.

And that was the year in a nutshell, marked by wonderful events made possible by the CVMA. Special thanks to **Janie Racette's** capable coordination of the SCVMA, for which I am deeply grateful.

In closing, I would like to thank the members of the SCVMA Committee: **Lindsay Gallant** (AVC), **Allison Kwantes** (UCVM), **Andrei Madaras** (OVC) and **Laura Shaw** (WCVM). Working with you this past year has been a great pleasure, and I am happy to count you among my future colleagues.

I look forward to seeing you soon in person at the FMV during the SCVMA 2024 Symposium!

(by Adalaïs Gibert, FMV, Graduating class of 2024)

provinciales ont pu venir se présenter à la communauté étudiante de la faculté. L'ACMV a bien sûr été invitée. Le représentant du Québec au Conseil de l'ACMV, le **Dr Jordyn Hewer**, a ainsi pu parler directement avec les étudiants, leur faisant part des mandats et des rôles de l'ACMV au cours de leurs études ainsi qu'au sein de leur future profession.

L'année s'est donc déroulée ainsi, marquée par de beaux évènements rendus possibles grâce à l'ACMV, et notamment grâce à **Janie Racette** qui coordonne brillamment le CEACMV et que je remercie infiniment.

Je tiens pour finir à remercier les membres du Comité étudiant de l'ACMV : **Lindsay Gallant** (AVC), **Allison Kwantes** (UCVM), **Andrei Madaras** (OVC) et **Laura Shaw** (WCVM). Travailler à vos côtés dans cette dernière année a été un réel plaisir et je suis heureuse de vous compter parmi mes futurs collègues.

J'espère vous voir tous bientôt en personne lorsque vous nous rendrez visite à la FMV pendant le Symposium du CEACMV de 2024!

(par Adalaïs Gibert,
FMV, promotion de 2024)

SCVMA Farewell Letter

This year has passed quickly and there is so much that every veterinary student can be proud. Everyone's continued dedication and determination to accomplish another year, gain deeper knowledge, refine clinical skills, and balance work with any other unexpected obstacles that arose in ones' path, is something to celebrate!

It has been a privilege and honor to be able to represent the SCVMA this past year and to be a representative on CVMA Council. The SCVMA has had many accomplishments from, enriching One Voice presentations, to the highly successful Symposium (and consequentially developing friendships across the nation), to country-wide support for our fellow students after Hurricane Fiona, to SCVMA-sponsored wellness events, and much more. Thank you to the CVMA/SCVMA for allowing me the opportunity to represent my fellow colleagues. I am appreciative of the experiences I have been able to have, as well as the connections I have made with wonderful students and veterinarians across Canada during my time in this role.

I also want to extend a warm congratulations to this year's graduating class of 2023! Best of luck to all graduates across Canada as they start out in their career, and are able to use their well-developed knowledge and skills to help and uplift the communities in which they work. I hope that your first year out is as enriching, challenging, and thrilling as you hope.

Next, I would like to thank my senior SCVMA committee members for their continuous hard work and dedication to their positions, which they held on top of their regular schooling throughout this year. Thank you to **Lindsay Gallant** (AVC), **Adalaïs Gibert** (FMV), **Andrei Madaras** (OVC) and **Laura Shaw** (WCVM), as well as the junior representatives, **Grace Munro** (AVC), **Alice Cheng** (FMV), **Mitchel Kvacica** (OVC),

Lettre de fin de mandat au CEACVM

La dernière année a passé très vite et il y a tant de choses dont nous pouvons tous être fiers. Notre persévérance et notre détermination à terminer une autre année, à acquérir des connaissances plus approfondies, à peaufiner nos compétences cliniques et à trouver un équilibre entre le travail et les imprévus sont des choses à célébrer!

Cela a été un privilège et un honneur pour moi de pouvoir représenter la communauté étudiante au cours de la dernière année et de siéger au Conseil de l'ACMV. Le CEACMV a plusieurs réalisations à son actif, allant des présentations « Une voix » enrichissantes au Symposium très réussi (qui a permis de nouer de nouvelles amitiés d'un bout à l'autre du pays), en passant par du soutien à l'échelle nationale pour nos camarades ayant subi l'ouragan Fiona et divers événements axés sur le mieux-être. Je tiens à remercier sincèrement l'ACMV et le CEACMV de m'avoir donné l'occasion de représenter mes confrères et consœurs. Je suis très reconnaissante pour les expériences que j'ai vécues et les liens que j'ai tissés avec d'extraordinaires étudiants et vétérinaires partout au Canada au cours de mon mandat.

Je tiens également à féliciter chaleureusement la promotion de 2023! Je vous souhaite la meilleure des chances alors que vous entreprenez votre carrière et mettez à profit les connaissances et les compétences que vous avez acquises pour aider et soutenir vos communautés. J'espère que votre première année de pratique sera aussi enrichissante, stimulante et palpitante que vous l'espérez.

J'aimerais souligner le travail et le dévouement exemplaires de mes collègues du CEACMV, malgré les exigences de leurs études régulières, tout au long de l'année. Merci aux autres représentants séniors, **Lindsay Gallant** (AVC), **Adalaïs Gibert** (FMV), **Andrei Madaras** (OVC) et **Laura Shaw** (WCVM), ainsi qu'aux représentants juniors, **Grace Munro** (AVC), **Alice Cheng**

Allison Kwantes

Sukhjit Sidhu (UCVM) and **Bailey Brazeau** (WCVM). It was an incredible delight to get to know each of you and work alongside you this past year. None of SCVMA's events would have been as successful as they were without your commitment, enthusiasm, and perseverance. A huge thank you as well to **Janie Racette** who kept us all in line and would always provide endless support, encouragement and laughs whenever needed. I hope that I will be lucky enough to work with any of you in the future again!

For all current students and incoming students, I want to remind you that the SCVMA/CVMA is always present to provide resources, offer support, and build relationships for every moment in your continued academic journey (and thereafter). I wish an incredible year to Grace Munro as she starts her year as SCVMA President for 2023–2024; I know that she will excel and will have great success in her upcoming presidential year.

Remember you are all members of the national and international voice of Canadian veterinarians — the CVMA! All the best in the upcoming summer and school year!

(by Allison Kwantes, SCVMA President, 2022–2023,
University of Calgary Faculty of Veterinary Medicine, Class of 2024)

(FMV), **Mitchel Kvacica** (OVC), **Sukhjit Sidhu** (UCVM) et **Bailey Brazeau** (WCVM). J'ai eu beaucoup de plaisir à collaborer avec vous et à apprendre à vous connaître. Aucun des événements du CEACMV n'aurait eu autant de succès sans votre engagement, votre enthousiasme et votre persévérance. Un immense merci également à **Janie Racette** qui a su nous maintenir sur la bonne voie et qui était toujours là pour nous apporter un soutien inestimable, des encouragements et des éclats de rire quand nous en avions besoin. J'espère que j'aurai la chance de travailler à nouveau avec vous tous à l'avenir!

J'en profite pour rappeler à tous les étudiants actuels et nouveaux que le CEACMV et l'ACMV offrent des ressources, du soutien, et des occasions d'établir des relations tout au long de votre parcours académique (et professionnel par la suite). Je souhaite une excellente année à Grace Munro qui assumera la présidence du CEACMV pour 2023-2024 – je n'ai aucun doute qu'elle excellera et aura beaucoup de succès dans ses fonctions.

N'oubliez pas que vous êtes tous membres de l'ACMV, qui incarne la voix nationale et internationale des vétérinaires canadiens! Passez un bel été et au plaisir de vous retrouver à l'automne!

(par Allison Kwantes, présidente du CEACMV
pour l'année 2022-2023, UCVM, promotion de 2024)

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Semaine de la santé animale du 1er au 7 octobre 2023
Ça prend une équipe... pour protéger la santé de votre animal et la vôtre

Animal Health Week (AHW) is an annual national public awareness campaign organized by the Canadian Veterinary Medical Association (CVMA) and hosted by veterinarians across Canada. Each year, through AHW, the veterinary community draws attention to an important health-related message. From October 1–7, 2023, the CVMA is celebrating its annual Animal Health Week campaign by raising awareness about the importance of the community of veterinary healthcare workers and animal owners it takes to help raise happy and healthy animals. This year's theme is *It Takes a Team… To Protect Your Animal's Health and You.*

The CVMA aims to use this year's theme to educate the public about the importance of the veterinary team as a whole to protect both animal and human health. There's no one more qualified to help safeguard the health and well-being of animals

La Semaine de la santé animale est une campagne nationale annuelle de sensibilisation du public organisée par l'Association canadienne des médecins vétérinaires (ACMV) et mise en œuvre par les médecins vétérinaires du Canada. Chaque année, dans le cadre de la Semaine de la santé animale, la communauté vétérinaire attire l'attention sur un important message lié à la santé. Ainsi, du 1er au 7 octobre 2023, l'ACMV sensibilisera le public à l'importance de la communauté des membres des équipes vétérinaires et des propriétaires pour que les animaux puissent vivre heureux et en santé. C'est pourquoi le thème choisi cette année est *Ça prend une équipe... pour protéger la santé de votre animal et la vôtre.*

L'ACMV exploitera ce thème pour sensibiliser le public à l'importance de tous les membres de l'équipe vétérinaire pour protéger la santé animale et humaine. En effet, personne n'est plus qualifié pour contribuer à préserver la santé et le bien-être des

than a team of dedicated and highly trained veterinary professionals. Veterinary teams work tirelessly to keep animals healthy, from routine check-ups and vaccinations to specialized treatments for any number of illnesses and conditions. But veterinary teams don't just safeguard animal health — by ensuring animal health and happiness, they help protect the safety of clients.

By providing regular check-ups and preventative medicine, you can help identify and treat potential health issues before they become serious problems. This not only keeps animals healthy, but also helps reduce the risk of zoonotic diseases. Additionally, veterinary teams are trained to handle a wide variety of emergencies and can provide first aid and critical care in the event of an accident or illness. By working closely with your clients and providing them with the knowledge and resources they need to keep their animals healthy, you can help protect the health and safety of both animals and their owners.

We hope you will help us share this message by displaying the free Animal Health Week posters, included in the June issue of *The Canadian Veterinary Journal* and a mailing sent to every veterinary practice nationwide in June. Educational tools, including a social media campaign, articles, and other resources are also available to promote Animal Health Week to clients and can be found on the AHW page of the *Practice Tools* section under the *Veterinary Resources* tab of the CVMA website (www.canadianveterinarians.net). Please share the prewritten social media posts, with accompanying images, on your practice's social media accounts to help us educate the public about how *It Takes a Team… To Protect Your Animal's Health and You.*

2023 Animal Health Week sponsor

Generous support of the 2023 Animal Health Week campaign is provided by Program Sponsor, **Petsecure Pet Health Insurance.**

Veterinary teams are driven by their values, skills, and passion for pet healthcare. Petsecure recognizes the amazing contributions of each team member from the veterinary assistants and client care teams to the veterinary technicians and technologists who practice alongside veterinarians as they deliver great medicine to patients. Petsecure offers customizable plans that allow all pet owners the opportunity to say yes to the best care for their cats and dogs.

Our plans help clients cover the costs of treatments for accidents, illnesses, dental conditions, behavior problems, including exam fees, emergency fees, and taxes. We also have wellness options and unlimited plans for clients who want the very best for their pet's healthcare.

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CANADA'S PET INSURANCE

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L'ASSURANCE CANADIENNE
POUR ANIMAUX DE COMPAGNIE

animaux qu'une équipe de professionnels vétérinaires dévoués et compétents. Les équipes vétérinaires travaillent sans relâche pour garder les animaux en bonne santé, que ce soit par les examens de routine, la vaccination ou le traitement de diverses maladies et affections. Mais elles ne se contentent pas de protéger la santé animale : en veillant à la santé et au bien-être des animaux, elles contribuent aussi à protéger la sécurité des clients.

Les bilans de santé et les soins préventifs réguliers aident à détecter et à traiter les problèmes de santé potentiels avant qu'ils ne deviennent des problèmes graves. Cela permet non seulement de garder les animaux en bonne santé, mais aussi de réduire le risque de maladies zoonotiques. De plus, les équipes vétérinaires sont formées pour gérer un vaste éventail d'urgences et peuvent fournir les premiers soins et les soins critiques en cas d'accident ou de maladie grave. En travaillant en étroite collaboration avec vos clients et en leur donnant les connaissances et les ressources dont ils ont besoin pour garder leurs animaux en bonne santé, vous pouvez aider à protéger la santé et la sécurité des animaux et de leurs propriétaires.

Nous espérons que vous nous aiderez à sensibiliser le public grâce à l'affiche gratuite de la Semaine de la santé animale, jointe au numéro de juin de *La Revue vétérinaire canadienne* et envoyée à toutes les pratiques vétérinaires du pays par la poste en juin. Des outils éducatifs, y compris une campagne sur les médias sociaux, des articles et d'autres ressources pour promouvoir la Semaine de la santé animale auprès des clients sont aussi disponibles à partir de la page de la Semaine de la santé animale de la section *Outils pour la pratique* sous l'onglet *Ressources pour les médecins vétérinaires* du site Web de l'ACMV (www.veterinairesaucanada.net). Nous vous invitons à partager nos publications pour les médias sociaux et les images qui les accompagnent sur les comptes de votre pratique pour diffuser le message que *ça prend une équipe… pour protéger la santé de votre animal et la vôtre*.

Commanditaire de la Semaine de la santé animale de 2023

La campagne de la Semaine de la santé animale de 2023 est généreusement soutenue par **Petsecure assurance maladie pour animaux de compagnie**.

Les équipes vétérinaires sont motivées par leurs valeurs, leurs compétences et leur passion pour les soins aux animaux. Petsecure reconnaît les contributions inestimables de chaque membre de l'équipe, des animaliers aux réceptionnistes en passant par les techniciens et technologues vétérinaires qui pratiquent aux côtés des médecins vétérinaires afin d'offrir une médecine de grande qualité aux patients. Petsecure propose des régimes d'assurance personnalisables qui permettent à tous les propriétaires de chiens et de chats de prodiguer les meilleurs soins à leurs animaux.

Les régimes de Petsecure aident les clients à couvrir les coûts des traitements pour les accidents, les maladies, les troubles dentaires ou les problèmes de comportement, y compris les frais d'examen, les frais d'urgence et les taxes. Des options pour les soins préventifs ou une couverture illimitée sont également offertes, pour les clients qui veulent le meilleur pour les soins de santé de leur animal de compagnie.

Petsecure sait que les médecins vétérinaires et leurs équipes sont confrontés à des conversations difficiles avec leurs clients

Petsecure knows that veterinarians and their teams face difficult conversations with clients when the best choice of treatment for a beloved pet is unaffordable. Our plans relieve those financial worries, so dogs and cats can receive the best care possible. By easing the stress involved in discussing veterinary fees, working with insured clients actively promotes clinic team engagement and emotional wellness.

Petsecure brings pet insurance knowledge directly to veterinary teams through visits by our territory managers and specialized Vetline support team. We offer pet insurance seminars, PIMS-friendly software solutions, and printed and digital client-support materials for our veterinary care team partners. We use our social media platforms to highlight the importance of all levels of the veterinary team, including our proud spotlight posts for individual clinics who celebrate pet healthcare through pet insurance.

Coordination of communication among veterinary teams, their clients, and our own engaged staff is an important part of what makes Petsecure special. We strive to understand the needs of our partner hospitals — and the pets and people for whom they care. Solid relationships with our veterinary colleagues and their clients power our passion for great healthcare for Canadian-insured cats and dogs.

CVMA members can contact our national sales team manager, **Chantelle Percy,** at (chantelle.percy@petlineinsurance.com) to connect with their territory manager and learn more about how Petsecure can support their veterinary teams and clients with our pet health coverage plans.

lorsque l'option de traitement optimale pour un animal bien-aimé est inabordable. L'assurance élimine cette préoccupation financière, afin que les chiens et les chats puissent recevoir les meilleurs soins possibles. En allégeant le stress lié à la discussion sur les frais vétérinaires, le travail avec les clients assurés favorise activement l'engagement des membres de l'équipe et leur bien-être émotionnel.

Chez Petsecure, nous faisons bénéficier les équipes vétérinaires de nos connaissances en matière d'assurance pour animaux de compagnie grâce aux visites de nos représentants et à notre ligne d'assistance réservée au personnel vétérinaire. Nous offrons à nos partenaires des équipes vétérinaires des séminaires sur l'assurance pour animaux de compagnie, des solutions adaptées aux logiciels de gestion de pratique, et de la documentation imprimée et numérique destinée aux clients. Nous utilisons nos plateformes de médias sociaux pour souligner l'importance de tous les membres de l'équipe vétérinaire, et nous faisons des publications qui mettent en vedette les pratiques qui célèbrent les soins de qualité grâce à l'assurance pour animaux de compagnie.

La coordination de la communication entre les équipes vétérinaires, leurs clients et notre propre personnel dévoué est un aspect important de ce qui distingue Petsecure. Nous nous efforçons de comprendre les besoins de nos pratiques partenaires – et des animaux et des gens dont elles prennent soin. De solides relations avec nos collègues vétérinaires et leurs clients alimentent notre passion pour les soins de santé de qualité pour les chats et les chiens assurés au Canada.

Les membres de l'ACMV peuvent communiquer avec **Chantelle Percy**, gestionnaire nationale des ventes, au chantelle.percy@petlineinsurance.com pour connaître le représentant de leur région et en savoir plus sur la façon dont Petsecure peut soutenir leurs équipes vétérinaires et leurs clients grâce aux régimes d'assurance maladie pour animaux de compagnie.

2023 World Rabies Day
World Rabies Day is Celebrated Annually on September 28th

Journée mondiale contre la rage de 2023
La Journée mondiale contre la rage est célébrée chaque année le 28 septembre

World Rabies Day is the first and only global day of action and awareness for rabies prevention. It is an opportunity to unite as a community — helping individuals, NGOs, and governments connect and share their work. The Canadian Veterinary Medical Association (CVMA) joins countries from around the world to promote rabies awareness and prevention.

September 28, 2023, marks the 17th World Rabies Day. This year's theme ***All for 1, One Health for All*** highlights the need for collaboration, the importance of equality, and strengthening overall health systems by ensuring that One Health is available to everyone.

La Journée mondiale contre la rage est la première et la seule journée d'action et d'éducation sur la prévention de la rage à l'échelle mondiale. Elle est une occasion de s'unir en tant que communauté, et d'aider les individus, les ONG et les gouvernements à se concerter et à partager leur travail. L'Association canadienne des médecins vétérinaires (ACMV) se joint aux intervenants d'autres pays du monde pour promouvoir la sensibilisation à la rage et la prévention de cette maladie.

Le 28 septembre 2023 marquera la 17e Journée mondiale contre la rage. Le thème de cette année, ***Tous pour 1, une seule santé pour tous***, souligne l'importance de la collaboration, de l'égalité, et du renforcement des systèmes de santé en général en veillant à ce que l'approche « Une seule santé » soit accessible à tous.

- "All for 1" expresses the responsibility each of us has in the battle to eliminate rabies. Everyone can work toward One Health, and everyone can contribute to saving lives. Communities can work together to help individual people and animals, and everyone can work toward a single goal effectively.
- The number 1 can refer to a single person making a difference, to a community, to our one goal, to how one vaccinated animal protects all, and how a single course of PEP (post-exposure prophylaxis) can save a life.

The theme addresses key trends within the rabies community, including collaboration seen through the United Against Rabies Forum, and discussions and actions to operationalize One Health — improving human, animal, and environmental health as the 3 are inextricably linked. Furthermore, it addresses key global trends, with the launch of the Pandemic Prevention Fund from the World Bank and the need to strengthen overall health systems. This can be achieved by building capacity through rabies control and elimination efforts and laying the foundation for other disease/health interventions.

This year's banner brings together all key elements of rabies prevention, highlighting the need for collaboration and a mix of approaches. We cannot eliminate rabies through dog vaccination or data collection alone. We cannot eliminate rabies through education or PEP access alone. Each situation requires its own tailored approach to educate the public, vaccinate dogs, monitor cases, and work with all relevant authorities to create a truly One Health rabies elimination strategy.

Rabies affects everyone, whether in endemic or rabies-free countries and One Health is for everyone. In this light, #Every1 needs to participate in eliminating rabies and achieving One Health!

- « Tous pour 1 » exprime la responsabilité de chacun d'entre nous dans la lutte pour éliminer la rage. Nous pouvons tous agir en conformité avec le concept « Une seule santé » et contribuer à sauver des vies. Les communautés peuvent collaborer pour aider les personnes et les animaux, et tout le monde peut travailler efficacement vers l'atteinte d'un objectif commun.
- Le chiffre 1 peut faire référence à une seule personne qui fait la différence, à une communauté, à notre objectif commun, à la façon dont un animal vacciné protège un grand nombre d'êtres vivants, à la façon dont un seul traitement de prophylaxie post-exposition (PPE) peut sauver une vie.

Le thème aborde également les principales tendances au sein de la communauté de la lutte contre la rage, notamment la collaboration observée dans le cadre du United Against Rabies Forum, ainsi que les discussions et les actions visant à rendre opérationnelle l'initiative « Une seule santé » pour améliorer la santé humaine, animale et environnementale en sachant que ces trois éléments sont inextricablement liés. Il tient également compte de tendances mondiales clés, dont le lancement du Pandemic Prevention Fund de la World Bank et la nécessité de renforcer les systèmes de santé en général. Cela peut être réalisé en augmentant les capacités grâce à des efforts de contrôle et d'élimination de la rage et en jetant les bases d'autres interventions en lien avec la santé.

La bannière de cette année rassemble tous les éléments clés de la prévention de la rage, et souligne la nécessité d'une collaboration et d'approches diversifiées. Nous ne pouvons pas éliminer la rage uniquement par la vaccination des chiens ou la collecte de données. Nous ne pouvons pas éliminer la rage seulement par l'éducation ou l'accès à la PPE. Chaque situation nécessite sa propre approche sur mesure pour sensibiliser le public, vacciner les chiens, surveiller les cas et travailler avec toutes les autorités

Zero by 30: Global Strategic Plan for the elimination of dog-mediated human rabies deaths by 2030

In 2015, the world called for action by setting a goal of zero human dog-mediated rabies deaths by 2030, worldwide. The World Health Organization (WHO), the World Organisation for Animal Health (WOAH), the Food and Agriculture Organization of the United Nations (FAO), and the Global Alliance for Rabies Control (GARC) have joined forces, as the United Against Rabies collaboration, and are determined to reach this goal.

The United Against Rabies collaboration leverages existing tools and expertise in a coordinated way to empower, engage, and enable countries to save human lives from this preventable disease. The global strategic plan puts countries at the center with renewed international support to act.

The global strategic plan prioritizes the societal changes needed to reach Zero by 30 into 3 objectives:

1. To effectively use vaccines, medicines, tools, and technologies.
   a. Reduce human rabies risk
      i. improved awareness and education
      ii. increased access to healthcare, medicines, and vaccines
      iii. dog vaccinations
2. To generate, innovate and measure impact.
   a. Provide guidance and data
      i. effective policies, guidance, and governance
      ii. ensuring reliable data to enable effective decision-making
3. To sustain commitment and resources.
   a. Harness multi-stakeholder engagement
      i. demonstrate the impact of activities completed under the United Against Rabies collaboration.

This One Health collaboration engages experts and stakeholders from the public and private sectors to have an active role in empowering, supporting and engaging countries to prevent rabies and make zero human deaths from rabies by 2030 a reality.

World Rabies Day events

Visit the Global Alliance for Rabies Control (GARC) website (https://rabiesalliance.org/world-rabies-day) to find information about organizing World Rabies Day events. You will find event toolkits, awareness resources, and free downloadable logos in multiple languages. Use #WorldRabiesDay to promote your event.

GARC also offers free online courses to improve the skills and knowledge of people working in rabies awareness and prevention.

CVMA offers information for pet owners

The CVMA offers a Rabies Fact Sheet and Rabies Prevention Tips for Pet Owners under its animal owner section (https://www.canadianveterinarians.net/public-resources/animal-owners/). Feel free to share this information with your clients and through your social media channels.

Working together against rabies helps people and animals live safely together, free from rabies.

compétentes pour créer une véritable stratégie d'élimination de la rage fondée sur le concept « Une seule santé ».

La rage affecte tout le monde, que ce soit dans les pays où elle est endémique ou qui en sont exempts, et le concept « Une seule santé » s'applique à tous. Dans cette optique, nous devons tous participer à l'élimination de la rage et à l'approche « Une seule santé »!

Zéro d'ici 2030 : Plan stratégique mondial pour l'élimination des décès humains dus à la rage transmise par les chiens d'ici 2030

L'objectif d'éliminer les décès d'humains dus à la rage transmise par les chiens partout dans le monde d'ici 2030 a été établi en 2015. L'Organisation mondiale de la santé (OMS), l'Organisation mondiale de la santé animale (OMSA), l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO) et la Global Alliance for Rabies Control ont uni leurs forces et formé le collectif United Against Rabies dans le but d'atteindre cet objectif.

Le collectif United Against Rabies tire parti de l'expertise et des outils existants de manière coordonnée pour favoriser la sensibilisation et l'engagement dans les différents pays afin d'éliminer les décès humains provoqués par la maladie évitable qu'est la rage. Le plan stratégique mondial place les pays au centre, avec un soutien international renouvelé pour agir.

Le plan stratégique mondial priorise les changements sociétaux nécessaires pour atteindre l'objectif « zéro d'ici 2030 » en trois objectifs distincts :

1. Utiliser efficacement les vaccins, les médicaments, les outils et les technologies
   a. Réduire le risque de rage humaine
      i. Accroître la sensibilisation et l'éducation
      ii. Améliorer l'accès aux soins de santé, aux médicaments et aux vaccins
      iii. Vacciner les chiens
2. Agir, innover et mesurer l'impact
   a. Fournir des conseils et des données
      i. Offrir des politiques, des conseils et une gouvernance efficaces
      ii. Fournir des données fiables pour permettre une prise de décision efficace
3. Maintenir l'engagement et les ressources
   a. Obtenir un engagement multipartite
      i. Démontrer l'impact des activités menées dans le cadre du collectif United Against Rabies

Cette collaboration « Une seule santé » donne aux experts et aux intervenants des secteurs public et privé un rôle actif dans l'autonomisation, le soutien et l'engagement des pays à prévenir la rage et à atteindre l'objectif de zéro décès humain dû à la rage d'ici 2030.

Activités de la Journée mondiale contre la rage

Visitez le site Web de la Global Alliance for Rabies Control (GARC) (https://rabiesalliance.org/world-rabies-day) pour savoir comment organiser un événement dans le cadre de la Journée mondiale contre la rage. Vous y trouverez des outils pour la planification d'activités, des ressources pour la sensibilisation du public, et des

logos à télécharger gratuitement en plusieurs langues. Utilisez les mots-clics #JournéeMondialeContreLaRage et #WorldRabiesDay pour promouvoir votre événement.

La GARC propose également des cours en ligne gratuits pour améliorer les compétences et les connaissances des personnes qui travaillent dans le domaine de la sensibilisation à la rage et de la prévention de cette maladie.

L'ACMV offre de l'information aux propriétaires d'animaux de compagnie

L'ACMV propose une fiche d'information sur la rage et des conseils de prévention de la rage dans la section de son site Web destinée aux propriétaires d'animaux (https://www.veterinairesaucanada.net/ressources-publiques/proprietaires-d-animaux/). N'hésitez pas à partager ces renseignements avec vos clients et dans vos médias sociaux.

Le travail concerté contre la rage aide les gens et les animaux à vivre ensemble en sécurité, à l'abri de la rage.

Transforming Limitations into Possibilities: Discover Affordable, Fast and Easy Financing Solutions with Petcard!

Transformer les limites en possibilités : découvrez des solutions de financement abordables, rapides et faciles avec Petcard!

When your clients' beloved pets face unexpected medical emergencies, the financial burden can be overwhelming. Discover how veterinary procedure financing, in partnership with Petcard and the Canadian Veterinary Medical Association (CVMA), is revolutionizing the accessibility of emergency pet care.

Unveiling the challenges

It's a heartbreaking reality that economic concerns often hinder pet owners from providing optimal healthcare for their furry friends. As compassionate animal health providers, as a veterinarian you strive to offer the best care while being mindful of the financial constraints faced by your clients. However, when veterinary costs arise unexpectedly, what options are available to make quality care affordable?

The limitations of traditional approaches

While pet insurance has gained popularity in Canada, it may not cover pre-existing conditions, leaving owners in a difficult position during emergencies. In-house payment plans, although offered by some veterinarians, can strain clinic resources, complicate administrative tasks, and strain client relationships. Is there a better way to address these challenges and ensure pets receive timely and comprehensive care without these limitations?

Lorsque les animaux bien-aimés de vos clients sont en situation d'urgence médicale inattendue, le fardeau financier peut être un facteur important. Découvrez comment le financement des interventions vétérinaires en partenariat avec Petcard et l'Association canadienne des médecins vétérinaires (ACMV) révolutionne l'accès aux soins d'urgence pour animaux de compagnie.

Reconnaître que le coût des soins est un enjeu

C'est une réalité déchirante que les préoccupations financières empêchent souvent les propriétaires d'animaux d'offrir des soins de santé optimaux à leurs compagnons. En tant que professionnel vétérinaire compatissant, vous vous efforcez de prodiguer les meilleurs soins tout en étant conscient des contraintes financières auxquelles sont confrontés vos clients. Cependant, lorsque des frais vétérinaires imprévus surviennent, quelles sont les options disponibles pour rendre les soins abordables?

Limites des approches traditionnelles

Bien que l'assurance pour animaux de compagnie ait gagné en popularité au Canada, elle ne couvre pas toujours les affections préexistantes, ce qui place les propriétaires dans une position difficile en cas d'urgence. Les modalités de paiement échelonné offertes par certains établissements vétérinaires peuvent peser sur les ressources de l'entreprise, compliquer les tâches administratives et nuire aux relations avec les clients. Y a-t-il un meilleur moyen de faire en sorte que les animaux puissent recevoir des soins rapides et complets?

Avantages du financement des interventions vétérinaires

Le financement des interventions vétérinaires est une solution qui offre aux propriétaires d'animaux des options de paiement flexibles et accessibles. En s'associant à Petcard, un chef de file du financement, et à l'ACMV, les médecins vétérinaires peuvent offrir des options de financement rapides et abordables à leurs clients. Cette approche novatrice permet aux propriétaires de prendre des décisions éclairées sur la santé de leurs animaux de compagnie sans s'imposer un lourd fardeau financier immédiat.

The benefits of veterinary procedure financing

Enter veterinary procedure financing, a solution that provides pet owners with flexible and accessible payment options. By partnering with Petcard, a leading financing company, and the CVMA, veterinarians can offer fast and affordable financing options to their clients. This innovative approach empowers clients to make informed decisions about their pets' health without the immediate financial burden.

Simplified process, quick assistance

Applying for veterinary procedure financing through Petcard is a streamlined and efficient process. Pet owners can initiate the application either at the veterinarian's office or from the comfort of their own homes. With a straightforward online application or a quick phone call, applicants provide the necessary information and undergo a simple credit check. This efficient process ensures that treatment can commence promptly, minimizing delays and easing the financial strain on pet owners.

A path to financial flexibility

Through veterinary procedure financing, pet owners can break down daunting treatment costs into affordable monthly payments. Unlike traditional payment plans, the administrative burden is lifted from the veterinary clinic, allowing them to focus on providing exceptional care. Additionally, veterinary procedure financing often offers competitive interest rates, making it a viable and cost-effective alternative to credit cards or personal loans.

Empowering pet owners

By embracing veterinary procedure financing, veterinarians and pet owners can work together to ensure that financial constraints do not impede their pets' well-being. This collaborative approach enables pet parents to make decisions based on compassion and medical necessity rather than immediate financial limitations. It fosters a supportive environment where veterinary clinics and pet owners work hand-in-hand to prioritize the health and happiness of our furry companions. In times of emergency, the well-being of our pets should never be compromised due to financial limitations. Veterinary procedure financing, in partnership with Petcard and the CVMA, offers a transformative solution that empowers pet owners to provide the care their beloved companions need. By embracing this accessible and flexible financing option, veterinarians can ensure that financial worries no longer stand in the way of pets receiving the timely and comprehensive care they deserve.

CVMA members enjoy exclusive special benefits, incentives, and rewards. Register today at (www.petcard.com) or call 1-888-689-9876 to learn more.

Processus simplifié et assistance rapide

Faire une demande de financement d'intervention vétérinaire auprès de Petcard est un processus simple et efficace. Les clients peuvent effectuer la demande alors qu'ils sont à l'établissement vétérinaire ou dans le confort de leur foyer. Par une simple demande en ligne ou un appel téléphonique rapide, ils fournissent les renseignements nécessaires et se soumettent à une vérification de leur solvabilité. Ce processus efficace garantit que les traitements peuvent commencer rapidement, ce qui réduit les délais et allège la pression financière sur les propriétaires d'animaux.

Une flexibilité financière accrue

Grâce au financement des interventions vétérinaires, les propriétaires d'animaux peuvent amortir les coûts angoissants en paiements mensuels abordables. Contrairement au paiement échelonné traditionnel, le financement n'ajoute pas à la charge administrative des membres du personnel de l'établissement vétérinaire, ce qui permet à ces derniers de se concentrer sur la prestation de soins exceptionnels. En outre, le financement des interventions vétérinaires offre souvent des taux d'intérêt compétitifs, ce qui en fait une alternative viable et rentable aux cartes de crédit ou aux prêts personnels.

Donner aux propriétaires d'animaux les moyens de décider

Avec le financement des interventions vétérinaires, les médecins vétérinaires et les propriétaires d'animaux peuvent travailler ensemble pour s'assurer que des raisons pécuniaires n'entravent pas le bien-être des animaux de compagnie. Cette approche collaborative permet aux clients de prendre des décisions fondées sur la compassion et la nécessité médicale, plutôt que sur des contraintes financières immédiates. Elle favorise un climat positif dans lequel le personnel vétérinaire et les propriétaires d'animaux accordent la priorité à la santé et au bonheur des animaux. En situation d'urgence, le bien-être de nos compagnons ne devrait jamais être compromis en raison de considérations budgétaires. Le financement des interventions vétérinaires en partenariat avec Petcard et l'ACMV est une solution qui change la donne en permettant aux clients d'offrir à leurs animaux bien-aimés les soins qu'ils méritent. En adoptant cette option de financement accessible et flexible, les médecins vétérinaires peuvent s'assurer que les coûts ne soient plus un facteur qui empêche les animaux de recevoir les soins dont ils ont besoin, au moment où ils en ont besoin.

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Case Report Rapport de cas

Partial tarsal arthrodesis with closing wedge ostectomy for treatment of bilateral twisted leg deformity in a cat

Sawako Murakami, Masakazu Shimada, Yasushi Hara

Abstract — A 5-month-old male domestic shorthair cat was presented with severe bilateral hind-limb deformities that caused the cat to walk on the dorsal aspect of the metatarsals. Computed tomography (CT) images revealed that the calcaneus was externally rotated, and the distal end of the calcaneus was turned medially to the talus in both hind limbs. The cat was diagnosed with twisted leg deformity, a congenital tarsal hyperextension deformity (clubfoot). Based on CT images, closing wedge ostectomy was done at the level of the tarsometatarsal joint with the wider part facing laterally. Partial transection of the common calcaneal tendon was not performed. Nine weeks after surgery, the cat was able to walk and jump, with its paws correctly placed on the ground, despite the limited range of motion in the tarsal joints. Based on radiographs with maximum tarsal flexion, the angle of the partial tarsal arthrodesis limited the range of motion. This is apparently the first case report describing CT images and closing wedge ostectomy in a cat with twisted leg deformity.

Key clinical message:
This article reports the findings obtained from CT imaging of a cat with twisted leg deformity. The current case was successfully managed by closing wedge ostectomy without partial transection of the common calcaneal tendon.

Résumé — Arthrodèse partielle du tarse avec ostectomie de fermeture pour le traitement d'une déformation bilatérale des pattes tordues chez un chat. Un chat domestique à poil court mâle âgé de 5 mois a été présenté avec de graves déformations bilatérales des membres postérieurs qui ont amené le chat à marcher sur la face dorsale des métatarsiens. Les images de tomodensitométrie (CT) ont révélé que le calcanéus était en rotation externe et que l'extrémité distale du calcanéum était tournée médialement vers le talus dans les deux membres postérieurs. Le chat a été diagnostiqué avec une déformation de la jambe tordue, une déformation congénitale du tarse en hyperextension (pied bot). Sur la base d'images par CT, une ostectomie de fermeture a été réalisée au niveau de l'articulation tarsométatarsienne avec la partie la plus large tournée latéralement. Aucune section partielle du tendon calcanéen commun n'a été réalisée. Neuf semaines après l'opération, le chat était capable de marcher et de sauter, les pattes correctement posées au sol, malgré l'amplitude de mouvement limitée des articulations du tarse. Sur la base de radiographies avec une flexion tarsienne maximale, l'angle de l'arthrodèse partielle du tarse limitait l'amplitude de mouvement. Il s'agit apparemment du premier rapport de cas décrivant des images CT et une ostectomie de fermeture chez un chat présentant une déformation de la jambe tordue.

Message clinique clé :
Cet article rapporte les résultats obtenus à partir de l'imagerie CT d'un chat avec une déformation des pattes tordues. Le cas actuel a été géré avec succès par une ostectomie de fermeture sans section partielle du tendon calcanéen commun.

(Traduit par Dr Serge Messier)

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Twisted leg deformity, in which the affected hind limb has varus and external rotation deformities, is a congenital disease rarely observed in kittens (1–3). This disease is considered the equivalent of tarsal arthrogryposis (clubfoot) in humans. Although a similar condition has been identified in many animal species, its specific cause is unknown (1–8).

In human infants, the Ponseti method is a successful and widely used technique that involves applying a cast to an affected foot to reduce deformity (9,10). One study mimicked this technique using casts in affected kittens aged 1 to 4 mo and reported that the malformation was mitigated over time (2). However, other studies reported that older kittens required more interventional treatment, such as partial arthrodesis with external skeletal fixation or bone plates (1,3). Many of these treatments include partial transection of the common calcaneal tendon (1,3). Unfortunately, the treatment choice depends mainly on the surgeon's experience, and there is no established method to measure the severity of tarsal deformities.

In this case, we acquired computed tomography (CT) images of a cat with congenital clubfoot and measured the degree of varus deformity. The cat was successfully managed with closing wedge ostectomy without partial transection of the common calcaneal tendon.

Case description

A 5-month-old male domestic shorthair cat was brought to our university with severely deformed hind limbs (Figure 1 A). The deformity was present when the cat was rescued at approximately 1 wk of age and had not deteriorated or improved since. The owner reported that the cat's siblings and its mother had no apparent hind-limb deformities. Clinical examination revealed hyperextension, varus, and external rotation at the tarsus of both hind limbs. Additionally, digits of both hind limbs were severely contracted, and the cat walked on the dorsal aspect of the metatarsals. Radiographically, there were no deformities of the tibia, metatarsal, or phalangeal bones (Figure 2 A, B, C, D).

Since physiotherapy was not effective, the owner consented to a surgical procedure. Surgery was done on the left hind limb first, and a CT image was obtained before surgery. Anesthesia was induced using propofol to effect and maintained using isoflurane. Fentanyl (3 μg/kg per hour) and medetomidine (1 μg/kg per hour) were administered IV during and after surgery for analgesia. Cefmetazole (25 mg/kg) was administered IV 20 min before surgery and every 90 min thereafter until completion of skin closure.

The CT image revealed that the calcaneus was externally rotated, and the distal end of the calcaneus was turned medially against the talus in both hind limbs. Hyperextension was present at the talocalcaneocentral and tarsometatarsal joints (Figure 3). The angle between the longitudinal axis of the talus and calcaneus was measured on a plane parallel to both the longitudinal axis of the calcaneus and the line connecting the medial and lateral styloid processes. The angle was defined as a plus for varus and minus for valgus. Angles for the left and right sides were 24.1 and 33.1°, respectively, whereas the mean angle for cats that underwent CT images unrelated to hind-limb deformity in our facility was −9.1° (range: −13.1 to −5.1°; 6 hind limbs of 3 cats). The measurement method of the varus angle of the left hind limb is shown in Figure 4.

The surgeon approached the tarsus by cutting the dorsal skin and retracting the tibialis cranialis and extensor digitorum longus muscles. The tarsus was contracted, precluding alignment correction without bone separation. Closing wedge ostectomy was done at the level of the tarsometatarsal joint with the wide part facing laterally. The angle of the ostectomy was determined using CT images. However, the surgeon adjusted the angle intraoperatively by aligning the proximal ostectomy line perpendicular to the tibia and distal to the metatarsus (Figure 5). Closure of the ostectomy site improved the varus alignment. Three plates were used to achieve partial arthrodesis of the tarsus. A 10-hole non-locking reconstruction plate (Mizuho, Tokyo, Japan) was applied from the lateral side of the calcaneus to the 5th metatarsal bone; a 7-hole straight locking compression plate (LCP; Johnson & Johnson, New Brunswick, New Jersey, USA) was applied from the cranial side of the calcaneus to the 4th metatarsal bone; and a 6-hole non-locking mini T-plate (Mizuho) was applied from the cranial side of the talus to the 3rd metatarsal bone (Figure 2 E, G). The mini T-plate and the reconstruction plate on the calcaneus were fixed with 2.0-millimeter screws and the remainder were fixed with 1.5-millimeter screws. The operation site was flushed with a saline solution before closure. A soft bandage was applied for 11 d postoperatively. Since the cat was stable the next day, right-side surgery was done 4 d later.

The same protocol was used for anesthesia, analgesia, and surgery, except that an 8-hole LCP T-plate (Johnson & Johnson) was applied from the cranial side of the talus to the 3rd metatarsal bone instead of the 7-hole straight LCP (Figure 2 F, H). The non-locking mini T-plate was fixed with 2.0-millimeter screws, and other plates were fixed with 1.5-millimeter screws. All implants were made of stainless steel. Using 3 plates did not make the incision closure difficult as all plates were < 1.5 mm thick and wedge ostectomy resulted in skin redundancy. A soft bandage was applied for 5 d postoperatively. The cat stood on the plantar surface of his paws postoperatively. Although the tarsal joints were hyperextended for a few weeks immediately after surgery (Figure 1 B), the hyperextension gradually improved as the calcaneal tendon softened (Figure 1 C).

The interval after surgery was uneventful. No particular rehabilitation therapy was applied because the cat was uncooperative. Nine weeks after surgery, the cat was able to walk and jump with paws on the ground, despite the limited range of motion of the tarsal joint. The passive range of motion was 50° (95° for flexion angle) on the left side and 54° (110° for flexion angle) on the right side. Each angle was measured as the cranial angle made by the metatarsal bones and tibia. Radiographs with maximum flexion of the tarsus revealed a space at the caudal part of the tarsocrural joint. The cranial cortex of the calcaneal bone appeared mounted on the craniodistal end of the tibia and created a gap on the caudal side of the joint (Figure 2 G, H). No improvement in digital flexion was observed. Bone union at the arthrodesis sites was visible on radiographs. The lateral implants were removed 32 wk after the initial surgery to prevent skin irritation. One month after implant removal, the cat was

Figure 1. Photographs of the kitten before (A), immediately after (B), and 13 mo after (C) surgery for twisted leg deformity. Before surgery, the kitten walked on the dorsal surface of the hind limbs distal to the tarsus. Both tarsi were hyperextended immediately after surgery, but the hyperextension was mitigated over time.

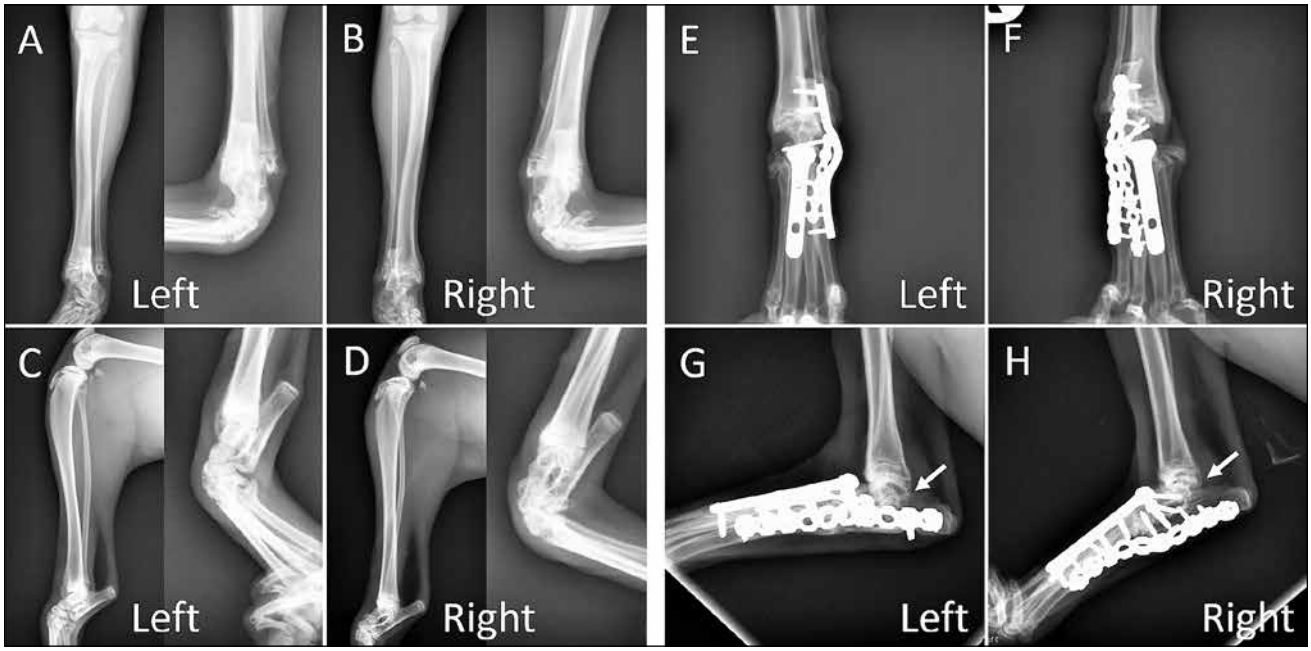

Figure 2. Radiographs obtained before (A, B, C, D) and 2 mo after surgery (E, F, G, H) for twisted leg deformity in a male cat. The mediolateral images with full flexion of the tarsus (G, H) exhibit the caudal gap between the trochlea of the talus and the distal tibia (white arrows).

bearing full weight on both hind limbs, and the owner reported improved quality of life compared to its preoperative condition.

Discussion

Twisted leg deformity in cats is a rare congenital disease, with only a few reports in the veterinary literature (1–3). This is apparently the first report describing the CT findings of the disease. Previous studies reported bone alignment deformities in the proximal tarsal joint (1,3). Our CT images revealed varus and external rotation in the calcaneus against the talus. However, hyperextension was present in both talocalcaneocentral and tarsometatarsal joints. We measured deformity by comparing the angle between the longitudinal axis of the talus and the calcaneus. This approach was based on the method used for measuring varus deformity in human patients (5). In this report, angles were measured as 3-dimensional angles; thus, rotational disposition was not described. Some human studies have described 2-dimensional measurements using radiographs (5,10). Although this approach would allow easier characterization of the deformity direction, uniform positioning of the deformed hind limbs would be challenging. Based on CT images, ostectomy angles were expected to be $> 30°$; however, the actual ostectomy angle was smaller than expected. One reason might be that other angles, including rotation or hyperextension, were not measured. Since the surgeon corrected the rotation and hyperextension along with the varus deformity, the angle that needed to be removed may have become smaller.

During surgery, soft tissue contracture was very severe, and a closing wedge ostectomy was done to correct the toe direction. Previous reports with partial arthrodesis did not use ostectomy techniques to improve alignment (1,3). One reason for this difference may be patient age. The cat in this report was 6 mo old when the surgery was completed, whereas cats in a previous study underwent the procedure at 3 mo of age (1).

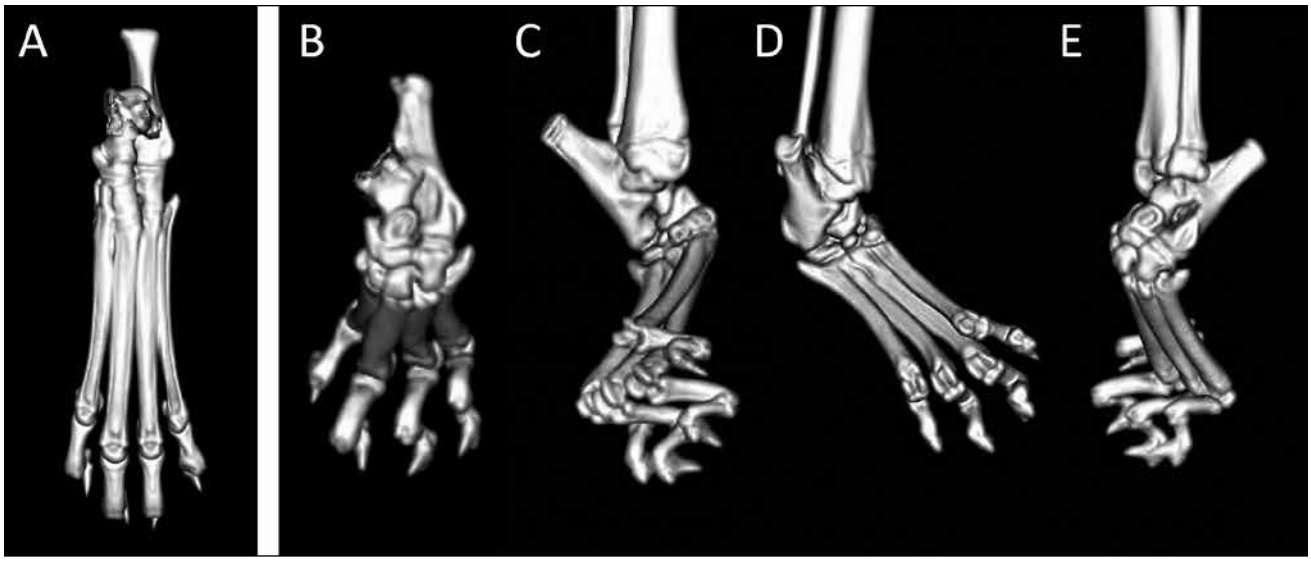

Figure 3. Three-dimensional CT images of a normal cat (A) and the kitten in this case (B, C, D, E). In cranial views (A, B), the tibia and fibula are removed to show the difference in bone alignment. Note the varus and external rotation of the calcaneus to the talus in (B) compared to (A).

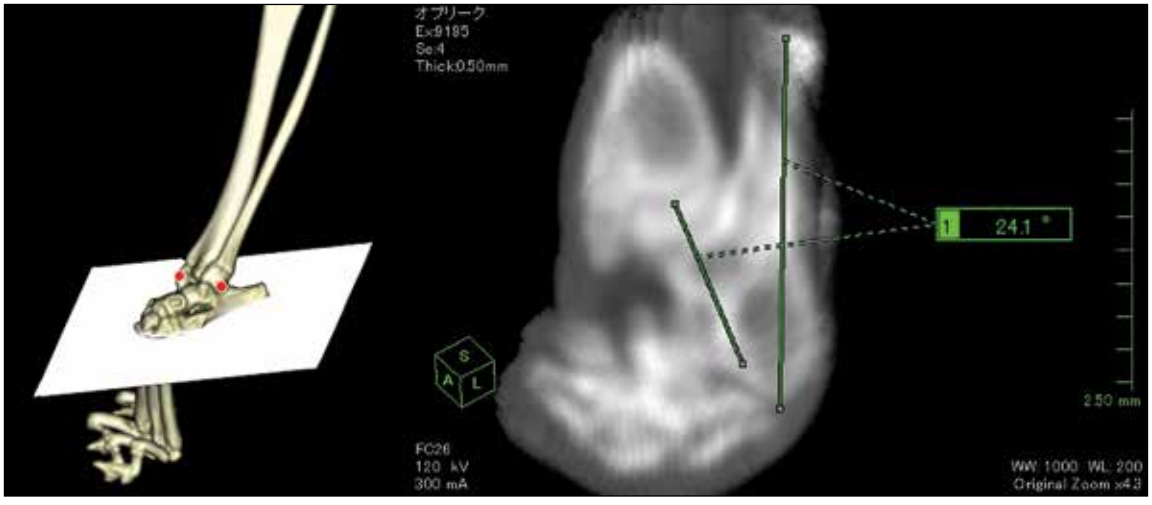

Figure 4. The image at left shows the plane parallel to both the longitudinal axis of the calcaneus and the line connecting the medial and lateral styloid processes. Note the 2 red dots at the medial and lateral styloid processes. The image at right shows the angle made by the longitudinal axis of the talus and calcaneus on this plane.

As a cat ages, soft tissue becomes hardened by fibrosis, making alignment correction difficult. In this case, closing wedge ostectomy was an efficient approach to adjust toe direction. We did not conduct a partial transection of the common calcaneal tendon. Hyperextension in the immediate postsurgical period was induced by the unbalanced length of the tibial bone and muscles, which could have been avoided by partial transection. However, in this case, the younger age may have worked in the cat's favor, softening the gastrocnemius muscle and adjusting it to the new alignment. The range of motion at the final examination was comparable to previous reports. Buote and Reese reported 90° as the flexion angle (2) but did not report the range. Bright *et al* reported 40° of flexion range and did not report the flexion angle (1). Although Yardimci *et al* did not report the actual angle at the final examination, a photograph taken 40 mo after frame removal showed a cat standing with its tarsus flexed at approximately 90° (3). This might justify the avoidance of partial transection of the common calcaneal tendon in some patients. In radiographs with tarsal joint flexion, it was apparent that the angle from the talus to the metatarsal bones was the cause of the limited range of motion. Since the metatarsus was tilted ventrally to the talus, bone contact at the cranial side limited full flexion of the tarsus. Care should be taken regarding the fixation angle for partial arthrodesis. The fixation angle on the sagittal plane is essential for achieving an adequate range of motion in the long term. Although we did not treat the severely flexed digits, they had little effect on locomotor performance, consistent with a previous report (3).

Twisted leg deformity in cats has been associated with varus and external rotation of the calcaneus in relation to the talus.

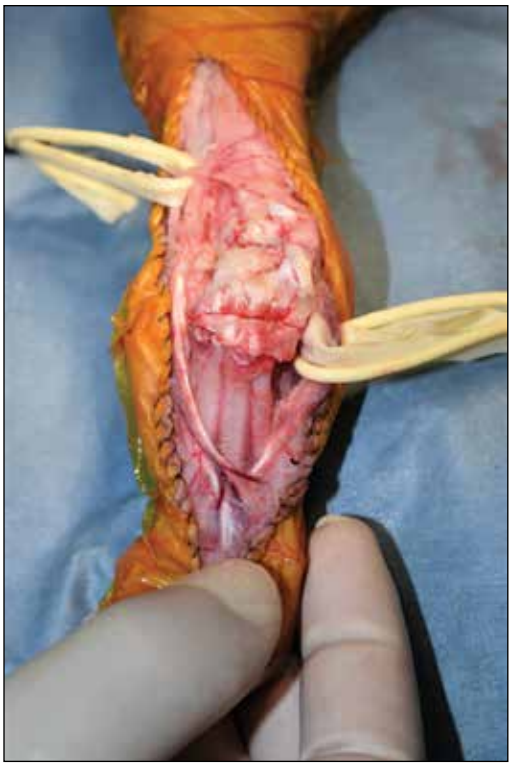

Figure 5. Left tarsus during surgery in a male cat. The right direction is medial, and the bottom direction is distal. Bone cuts were made for closing the wedge ostectomy.

Development of a measurement method for this deformity may facilitate determination of disease severity and treatment selection. For cats with advanced contraction of the tarsus, closing wedge ostectomy could be an effective method for correcting toe direction. Conversely, some cats may not require partial transection of the common calcaneal tendon, other than to improve the tarsal range of motion in the immediate postoperative period.

Acknowledgment

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Case Report Rapport de cas

Biphasic pleural mesothelioma in a goat

Lindsay M. Fry, Johnathan DenHerder, Gay Lynn Clyde, Laura A. Williams, David A. Schneider

Abstract — An 8-year-old Saanen goat doe was seen for inappetence, tachycardia, and intermittent bluish-grey discoloration of the oral mucous membranes. On physical examination, the goat was mildly tachypneic and tachycardic, with reduced sounds auscultated on the left side of the thorax. Euthanasia was elected. Necropsy revealed an infiltrative, multinodular mass within the left thoracic cavity and innumerable small, tan nodules disseminated across the pleura of the lungs, thoracic walls, and diaphragm. Upon histologic examination, the mass was composed of highly pleomorphic, fusiform to polygonal cells. Neoplastic cells exhibited positive immunoreactivity for both cytokeratin and vimentin, consistent with a diagnosis of biphasic pleural mesothelioma.

Key clinical message:
Mesothelioma has rarely been described in the goat but should be considered as a differential diagnosis for thoracic masses in small ruminants, along with thymoma; metastatic neoplasia; carcinomatosis; and granulomatous lesions caused by parasites, bacteria, and fungi.

Résumé — Mésothéliome pleural biphasique chez une chèvre. Une chèvre Saanen âgée de 8 ans a été vue pour de l'inappétence, une tachycardie et une décoloration gris bleuâtre intermittente des muqueuses buccales. À l'examen physique, la chèvre était légèrement tachypnéique et tachycardique, avec des sons réduits auscultés du côté gauche du thorax. Il a été décidé d'euthanasier l'animal. L'autopsie a révélé une masse multinodulaire infiltrante dans la cavité thoracique gauche et d'innombrables petits nodules brun clair disséminés à travers la plèvre pulmonaire, les parois thoraciques et le diaphragme. À l'examen histologique, la masse était composée de cellules hautement pléomorphes, fusiformes à polygonales. Les cellules néoplasiques ont présenté une immunoréactivité positive pour la cytokératine et la vimentine, compatible avec un diagnostic de mésothéliome pleural biphasique.

Message clinique clé :
Le mésothéliome a rarement été décrit chez la chèvre mais doit être considéré comme un diagnostic différentiel des masses thoraciques chez les petits ruminants, avec le thymome, la néoplasie métastatique, la carcinomatose et les lésions granulomateuses causées par des parasites, des bactéries et des champignons.

(Traduit par Dr Serge Messier)

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Thoracic masses in small ruminants are uncommon and can be either neoplastic or inflammatory in nature (1). In general, inflammatory etiologies are more commonly encountered. For instance, *Echinococcus* sp. infection can cause hydatid cysts in the pleura and peritoneum of small ruminants (2,3), and nematodes such as lungworms occasionally lead to granuloma formation throughout the lungs, pleural surfaces, and along airways (4). Bacteria such as *Corynebacterium pseudotuberculosis* and *Mycobacterium* sp. can lead to granulomatous pneumonia, lymphadenitis, and pleuritis (1,5,6), as can fungi such as *Cryptococcus* sp. and *Coccidioides* sp. (5,7).

Neoplasia involving the thoracic cavity of goats is comparatively rare (1). Thymomas are one of the most common neoplasms of goats and usually exhibit benign behavior (8–10). Many thymomas are discovered incidentally, and cases with clinical compromise are usually due to local expansion of the mass and compression of adjacent structures rather than to metastasis or tissue invasion (10). In a retrospective study of 100 goats with

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neoplasia, 8.8% of the tumors were thymomas (8); and in a second study of 67 dairy goats > 2 y old, 25.3% had thymomas at necropsy (9). Thymomas can be found in the cranial mediastinum, ventral cervical region, or both, and tend to occur in older goats (10).

Unfortunately, not all neoplasms of the caprine thoracic cavity exhibit benign behavior. It is rare to encounter malignant neoplasms in the thoracic cavity of goats, but when seen, these include primary pulmonary carcinoma, metastatic neoplasia, lymphosarcoma, and mesothelioma (1,8,11,12). Mesothelioma is an extremely rare malignant neoplasm in livestock species, but it has been documented in cattle, sheep, and goats, among others (11–16). As in humans, mesothelioma of domestic species can develop at any site lined by mesothelium, including the pleura, peritoneum, pericardium, and *tunica vaginalis* of the testes (17). Clinical signs seen are dependent on the affected site and are often secondary to effusion, local tumor expansion and infiltration, or distant metastasis (12). In livestock species, mesotheliomas of the pleura, peritoneum, and pericardium have been reported (11–13,15,18). Common clinical signs include dyspnea, tachypnea, tachycardia, ascites, and anorexia. The prognosis is extremely poor, with only minimal disease amelioration achieved by surgical, radiological, and chemotherapeutic interventions (17).

In this case report, we describe pleural mesothelioma in a goat, which, to our knowledge, has only once been previously described.

Case description

The 8-year-old Saanen goat doe described in this report served as a healthy control and breeding animal as part of a research project approved by the Washington State University Institutional Animal Care and Use Committee (approval #s 6665 and 6667). The goat was born and maintained in an indoor/outdoor animal housing facility in eastern Washington State, USA, and was current on annual immunization for the diseases caused by the toxins of *Clostridium perfringens* Types C and D and *C. tetani* (BarVac CD/T; Boehringer Ingelheim, Ridgefield, Connecticut, USA) and on endo-/ectoparasite control, when indicated by fecal and physical examinations [anthelmintics: fenbendazole (Panacur; Merck, Rahway, New Jersey, USA) or ivermectin (Ivomec; Boehringer Ingelheim); *Eimeria* control: amprolium (Corid; Merial, Duluth, Georgia, USA); chewing lice infestation: coumaphos (Co-Ral; Bayer, Shawnee Mission, Kansas, USA) or permethrin (Permectrin II; Bayer)]. Serology for *Coxiella burnetii* (last trimester of pregnancy) and small ruminant lentivirus were consistently negative over the life of this animal and herd. Prior to the illness described herein, the goat had experienced no major health problems.

Veterinary evaluation was requested due to 2 d of reduced appetite, reduced fecal and urine output, increased HR, and intermittent bluish-grey discoloration of the mucous membranes. On clinical examination, the doe was bright, alert, and responsive, and had pink, but tacky, mucous membranes. The doe was thin in body condition and the abdominal contour appeared bilaterally sunken. The rectal temperature (39.9°C), HR (156 beats/min), and Rf (respiratory rate: 56 breaths/min) were initially elevated. The rectal temperature and Rf later returned to within normal limits (temperature: 39.1°C, Rf: 36 breaths/min), although an expiratory abdominal effort and tachycardia persisted (120 beats/min). There was mild, bilateral, dry nasal discharge, and thoracic auscultation revealed reduced sounds on the left side. The only other significant clinical abnormalities were reduced and firm rumen fill and reduced rumen contractility. The results of a complete blood (cell) count (CBC) and blood smear were within normal limits, apart from a PCV of 45% [reference range (RR): 22 to 38%], which was attributed to dehydration. The plasma fibrinogen was 2 g/L (RR: 1 to 4 g/L). A serum chemistry panel revealed mild hyperproteinemia at 76 g/L (RR: 61 to 71 g/L) characterized by a low normal albumin at 26 g/L (RR: 25 to 35 g/L) and mild hyperglobulinemia at 50 g/L (RR: 27 to 41 g/L). Also noted were mild hypocalcemia at 2.10 mmol/L (RR: 2.25 to 2.97 mmol/L) and hypomagnesemia at 0.78 mmol/L (RR: 1.11 to 1.44 mmol/L), and mildly elevated sorbitol dehydrogenase at 31.9 U/L (RR: 14 to 30 U/L). Because this was an aged research animal, euthanasia and postmortem workup were elected to rule out diseases of potential concern to the rest of the herd.

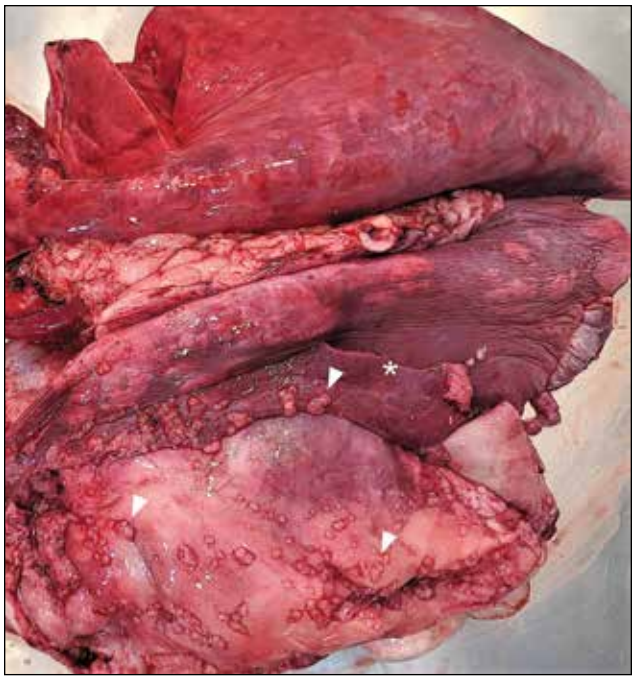

Figure 1. Dorsal aspect of the lungs of an 8-year-old goat doe, with the cranial aspect to the left of the image. Note that the left lung is almost entirely atelectatic (*). Numerous pale tan-colored nodules (arrowheads) are disseminated across the pleural surface.

Necropsy revealed an infiltrative, multinodular, tan mass within the left thoracic cavity, with diffuse atelectasis of the left lung lobes (Figure 1). The mass contained variably sized pockets of viscous, brown-green fluid. Innumerable small, tan nodules were disseminated across the visceral pleura of the lungs and parietal pleura of the thoracic walls and diaphragm. The mass minimally extended into the subpleural pulmonary parenchyma in few areas, and in one focus, extended through the mediastinum into the right thoracic cavity. Apart from

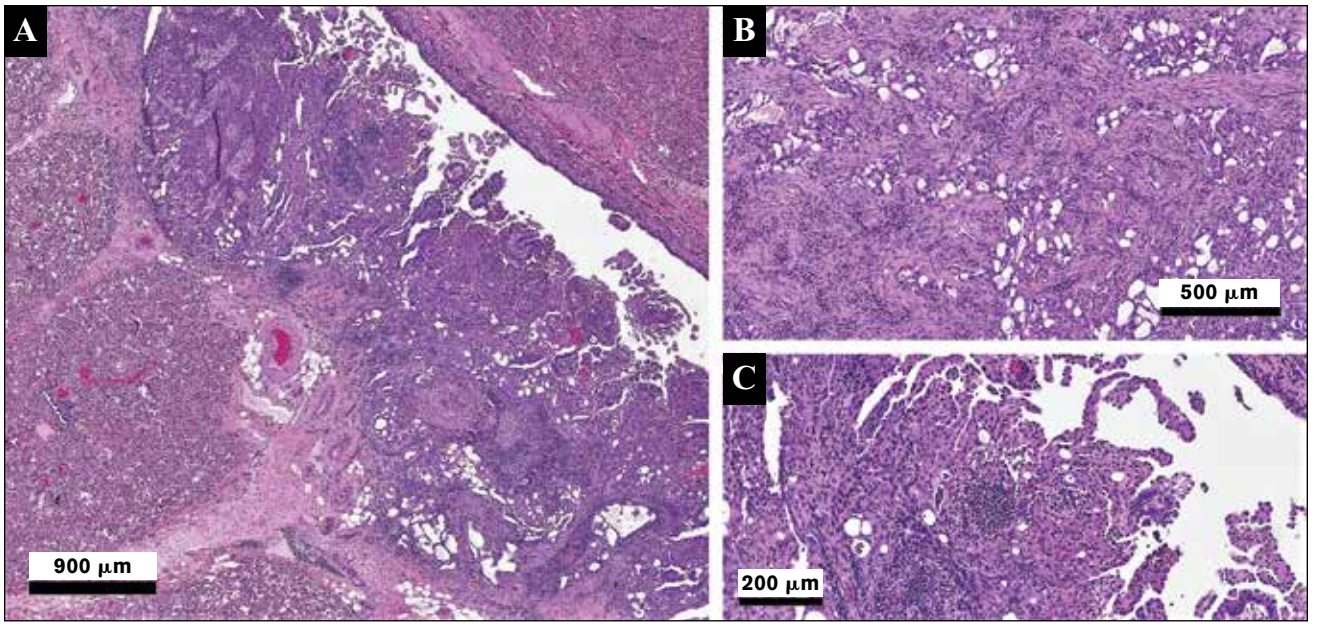

Figure 2. Pleural neoplasm in an 8-year-old goat. H&E staining. A – Sub-gross (2.5× magnification): The visceral pleura is expanded by a densely cellular mass that infiltrates into and effaces the lung. The mass is composed of nests, streams, bundles, and papillary projections of neoplastic cells supported by a fine to moderate fibrous stroma. B (20× magnification) and C (40× magnification) – Cells are round to polygonal to fusiform, with finely stippled chromatin and prominent nucleoli.

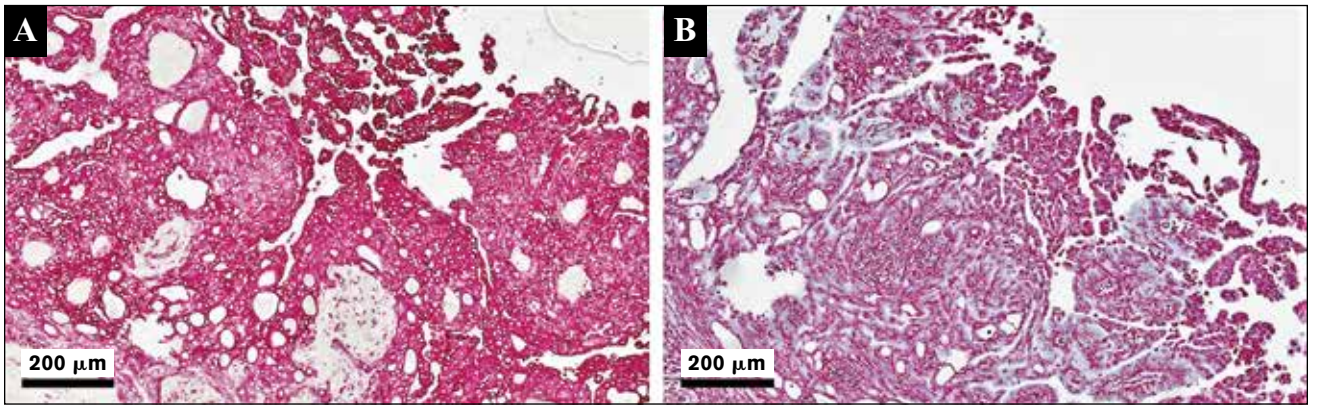

Figure 3. Pleural mass in an 8-year-old goat. Pancytokeratin (A) and vimentin (B) immunohistochemistry, 20× magnification. Neoplastic cells demonstrate strong immunoreactivity for both epithelial (A) and mesenchymal (B) cell markers. This finding, along with the gross appearance and location of the mass, is consistent with mesothelioma.

the mammary glands, which contained multiple areas of mild fibrocystic change, other tissues (brain, eyes, oral cavity, heart, trachea, esophagus, thyroid gland, gastrointestinal tract, spleen, liver, kidneys, adrenal glands, urinary bladder, musculoskeletal system, skin, uterus, and ovaries) were grossly normal.

Samples of the thoracic mass were collected, fixed for ~4 d in 10% neutral buffered formalin, trimmed into tissue cassettes, and submitted to the Histopathology Section of the Washington Animal Disease Diagnostic Laboratory (WADDL) for routine processing and generation of H&E-stained slides. Following evaluation of the H&E-stained slides, paraffin-embedded tissue blocks were resubmitted to the WADDL Histopathology Section for pancytokeratin and vimentin immunohistochemical staining. Slides were examined independently, by 2 ACVP Board-certified veterinary anatomic pathologists (LMF and LAW), using light microscopy.

Histologically and at several sites, the visceral pleura was expanded by an infiltrative, densely cellular, and poorly demarcated mass that effaced subjacent alveoli (Figure 2 A). The mass was composed of streams, bundles, nests, and papillary projections of spindloid to round to polygonal cells supported by a moderate fibrous stroma (Figure 2 B, C). Cells had a moderate amount of eosinophilic cytoplasm and variably distinct borders (Figure 2 B, C). Nuclei were ovoid to round, with finely stippled chromatin and 1 to 3 variably prominent, basophilic nucleoli (Figure 2 B, C). Anisocytosis and anisokaryosis were moderate to marked. There were 2 mitoses per 10 400× high-powered fields (HPF) in the spindloid cell population, and 3 mitoses per 10 400× HPF in the epithelioid population. In a few small, randomly scattered foci, neoplastic cells were necrotic. Low numbers of erythrocytes and mixed leukocytes were scattered throughout the sectional area. Both epithelioid and spindloid

cell populations exhibited strong, intracytoplasmic immunoreactivity for pancytokeratin and vimentin (Figure 3 A, B).

Discussion

The tachypnea, tachycardia, asymmetrically muffled cardiopulmonary auscultation results, and intermittent bluish-grey discoloration of mucous membranes noted during evaluation of the doe were suggestive of severe pathology of the thoracic cavity. These findings, coupled with the age of the animal, weight loss, and recent inappetence, were indicative of a poor prognosis. Due to the potential risk of an infectious etiology that could affect others in the herd, necropsy and histopathology were pursued to determine the definitive cause of clinical decline. The appearance of the mass at necropsy was consistent with malignant neoplasia, and our top differential diagnoses at that point were metastatic carcinoma, carcinomatosis, and mesothelioma. A thymoma was deemed unlikely based on the multinodular, infiltrative, and widely disseminated nature of the neoplasm. Blueish-grey discoloration of mucous membranes and unilaterally muffled cardiac and lung sounds appreciated during physical examination were likely the result of diffuse atelectasis of the left lung lobes coupled with the mass effect caused by neoplastic tissue and fluid-filled, cystic spaces within the pleural space.

Histologically, mesotheliomas are divided into epithelioid, sarcomatous, and biphasic (mixed) types (19). Epithelioid tumors are composed of polygonal to round cells that form nests and papillary projections, whereas sarcomatous tumors are composed of streams and bundles of fusiform cells (19). Biphasic tumors contain areas of both epithelioid and sarcomatous patterns, as shown in this case (19). Since mesotheliomas closely resemble many other tumor types histologically, immunohistochemistry is often necessary to reach a definitive diagnosis (12,17). Mesothelial cells are considered primitive mesodermal cells and have the capability to undergo both mesenchymal-to-epithelial and epithelial-to-mesenchymal transitions, depending on environmental cues (20). As such, mesotheliomas generally express both epithelial (*e.g.,* pancytokeratin) and mesenchymal (*e.g.,* vimentin) markers (12,17,20). The histomorphology, immunohistochemical labeling pattern, and gross appearance of the lesion were subsequently used to confirm a diagnosis of mesothelioma, as in this case.

To our knowledge, this is the second report of a pleural mesothelioma in a goat (11), and 3 other reports describe peritoneal mesotheliomas in goats (12,15,16). The other reported pleural mesothelioma (11) caused dyspnea, tachypnea, and inappetence. Pleural effusion was noted on radiographs, and mucinous fluid was obtained *via* thoracocentesis. The histologic description of that tumor was consistent with the epithelioid subtype. Two of the 3 peritoneal mesotheliomas in goats caused significant ascites and inappetence (15,16), and the 3rd (12) resulted in chronic weight loss, anemia, inappetence, lethargy, diarrhea, dyspnea, and mucous membrane pallor. The latter was reported to be a sarcomatous mesothelioma and exhibited widespread metastasis to the lungs and myocardium, as well as severe effacement of the liver, adrenal glands, kidneys, and uterus. One of the remaining 2 reported peritoneal mesotheliomas was of the biphasic subtype (15), and the subtype of the 3rd was unspecified (16).

In cattle, mesotheliomas are often congenital, and are primarily seen in the peritoneum of neonatal calves (21). Although 54 to 90% of mesotheliomas in humans are attributable to previous asbestos exposure (19,22) [likewise for some cases in dogs (23,24)], no definitive causation has been established for mesotheliomas of livestock and other veterinary species (12,17). However, as studies have documented accumulation of potentially carcinogenic particulates and fibers within the pleura, lungs, and lymph nodes of small ruminants (25), a similar pathogenesis is possible.

Although rare, thoracic cavity neoplasia should be considered as a differential diagnosis in middle-aged and geriatric small ruminants with evidence of respiratory compromise. In goats, thymoma is the most commonly encountered thoracic neoplasm; however, malignant tumors, including mesothelioma, should also be considered. In addition to neoplastic causes of thoracic cavity masses, cysts and granulomata caused by parasites, bacteria, and fungus can also cause severe mass effects in the thoraxes of small ruminants.

Acknowledgments

This work was supported by the USDA-ARS CRIS project numbers 2090-32000-042-000-00D and 2090-32000-044-000-00D. The authors acknowledge the excellent technical support provided by Lori Fuller. We also acknowledge the animal handling expertise of Emma Karel and Kirstin Erickson. CVJ

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Case Report Rapport de cas

Metastatic carcinoma of unknown origin in a dog

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Abstract — Although cancer of unknown primary origin (CUP) is well-described in the human literature, it is not as well-understood within veterinary medicine. This case report represents one of few focused on describing CUP in a dog.

Key clinical message:
Metastatic CUP should be considered as a differential diagnosis despite being a rare disease entity that is infrequently reported within the veterinary literature.

Résumé — Carcinome métastatique d'origine inconnue chez un chien. Bien que le cancer d'origine primaire inconnue (CUP) soit bien décrit dans la littérature humaine, il n'est pas aussi bien compris en médecine vétérinaire. Ce rapport de cas représente l'un des rares à s'intéresser à la description du CUP chez un chien.

Message clinique clé :
Le CUP métastatique doit être considéré comme un diagnostic différentiel bien qu'il s'agisse d'une entité de maladie rare rarement rapportée dans la littérature vétérinaire.

(Traduit par Dr Serge Messier)

Can Vet J 2023;64:833–838

Cancer of unknown primary origin (CUP) is a histologically diagnosed metastatic cancer in which the primary site cannot be identified despite a thorough diagnostic workup. In humans, only 20% of primary sites are identified prior to the patient's death (1), and the primary tumor remains unidentified following autopsy in 70% of cases (2,3). Cancer of unknown primary origin represents 3 to 5% of all human malignancies, making it 1 of the 10 most frequently diagnosed cancers worldwide (4).

Although CUP is relatively well-described in humans, it is sparsely described in the veterinary literature. To the authors' knowledge, there are few studies available for review (5–8) with a focus on CUP in veterinary patients. The purpose of this case report is to describe the clinical presentation of, diagnostic approach to (including the use of positron emission tomography-computed tomography, PET/CT), treatment of, and outcome of CUP in a dog.

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Case description

An 11-year-old intact male Labrador retriever dog was presented to the primary veterinarian for evaluation of a right ventral cervical mass. Pertinent past medical history included well-controlled diabetes mellitus and left forelimb digit 4 amputation to address a mass with unknown histological diagnosis or physical description. On physical examination, a right-sided, 5-centimeter (diameter) submandibular mass was noted. Cytology was consistent with carcinoma. The dog was returned 10 d later for surgical removal. Preoperative blood work revealed hyperglycemia [315 mg/dL; reference interval (RI): 74 to 153 mg/dL] and hyperglobulinemia (5.1 g/dL; RI: 2.5 to 4.5 g/dL). Histopathology was consistent with narrowly excised (margins < 1 mm) adenosquamous carcinoma. The mitotic count was 18 per 10 400× fields, including bizarre mitotic figures, and vascular invasion was present. As lymphoid proliferation was identified at the periphery, metastatic carcinoma to the right mandibular lymph node was suspected and referral was recommended.

Fifty-five days following initial diagnosis, the dog was presented to The Ohio State University Integrated Oncology

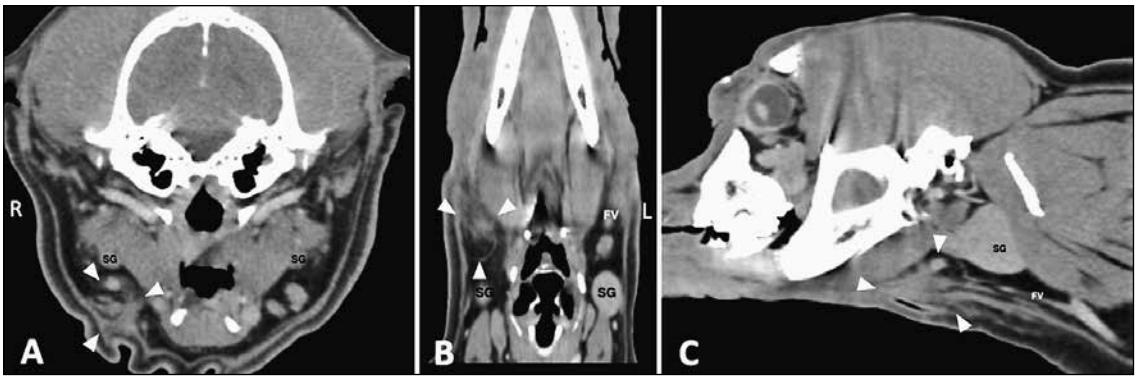

Figure 1. Initial (postoperative) skull computed tomography (CT) imaging at the level of the right mandibular mass resection, showing the mildly contrast enhancing, wispy, soft tissue stranding and ovoid to lobular nodules (arrowheads). Axial plane post-contrast image (A) and coronal reconstruction (B) at the level of the normal-appearing left mandibular lymph nodes. C – Right parasagittal post-contrast reconstruction. Soft tissue window width and window level 400/40; the slice thickness was 1.25 mm; the image was acquired with 120 kVp.

FV – Facial vein; SG – Mandibular salivary glands.

service (Columbus, Ohio, USA). Physical examination revealed prominent peripheral lymph nodes. Oral examination revealed no primary lesions, and the palatine tonsils were grossly normal. Three-view thoracic radiographs revealed no obvious pulmonary metastatic disease. Computed tomography (CT) of the skull and abdomen was completed under sedation using a multidetector CT, 64-slice with double z-sampling capabilities totaling 128-detector (GE Revolution EVO; GE Healthcare, Waukesha, Wisconsin, USA), at 120 kVp in a transverse plane and a slice thickness of 1.25 mm. Pre- and post-contrast imaging was completed using 60 mL (240 mg/mL) of iohexol administered IV through a peripheral indwelling catheter. The study was reformatted into dorsal, sagittal, and transverse planes. Skull CT showed moderate, mildly contrast-enhancing soft tissue stranding and lobular nodules in the region of the previously resected right mandibular lymph nodes. Given the recent surgery, these were thought to represent right mandibular subcutaneous fibrosis or cellulitis, with incompletely excised mandibular lymph nodes, or recurrent or persistent neoplasia (Figure 1). The right medial retropharyngeal lymph node was enlarged and concerning for either neoplasia or reactive inflammation. No abnormalities consistent with a primary tumor were identified. Abdominal CT showed no evidence of metastatic or primary neoplasia. The left and right medial retropharyngeal lymph nodes and left mandibular lymph node were sampled. Left mandibular and left medial retropharyngeal lymph node cytology revealed a mild expansion of intermediate-to-large lymphocytes consistent with lymphoid hyperplasia. Right medial retropharyngeal lymph node cytology revealed moderate lymphoid and plasma cell hyperplasia. Given these findings, the dog was diagnosed with metastatic carcinoma to the right mandibular lymph node of unknown origin.

To identify the primary tumor, full-body positron emission tomography-computed tomography (PET/CT) was completed under general anesthesia 77 d following initial diagnosis. Blood glucose prior to 2-deoxy-2-[18F]-fluorodeoxyglucose (18F-FDG) injection was 301 mg/dL. A dose of 3 MBq/kg (0.08 mCi/kg) of 18F-FDG was administered intravenously. The list mode time-of-flight raw data was acquired continuously on the Vereos PET/CT system (Philips, Amsterdam, Netherlands). Two-millimeter isotropic voxel data sets (288 × 288 matrix size using 576-millimeter field of view) and 90 seconds/bed were reconstructed. Transverse CT imaging was acquired using the multi-slice system at 120 kVp, 150 mAs, and reconstructed with a 0.625-millimeter slice thickness. A whole-body positron emission tomography (PET) image was acquired starting at 85 min after injection. The PET/CT showed mild to moderately increased activity in the region of the previously resected subcutaneous right mandibular neoplasm. There was mild to moderately increased left mandibular lymph node, bilateral parotid, medial retropharyngeal, and superficial cervical lymph node activity. Similar increased activity was seen in the popliteal lymph nodes bilaterally. In the palatine tonsils, there was asymmetrical increased activity (moderate on the right and mild on the left). Separately, a right caudal cervical region of mildly increased activity was seen in the dorsal subcutaneous tissues, associated with soft tissue stranding and an irregular soft tissue nodule. This lesion was suspected to be cellulitis secondary to iatrogenic insulin injections. The right mandibular subcutaneous and lymph node findings were nonspecific and were considered to represent either reactive inflammation and fibrosis secondary to the recent surgery or recurrent neoplasia. Increased activity in the palatine tonsils has been described as a common indeterminate finding due to lymphoid reactivity, inflammation, or periodontal disease (9). The remaining regions of increased activity were considered non-neoplastic. No primary neoplastic lesion was identified (Figure 2).

Given these findings, histopathological review from a second pathologist was obtained from the original biopsy. This confirmed the initial diagnosis of a well-differentiated adenosquamous carcinoma with widespread nodal effacement and vascular invasion (Figure 3). Restaging was recommended every 3 mo with skull CT and thoracic radiographs.

One hundred and fifty-five days following initial presentation, a prominent, firm, right superficial cervical lymph node was identified. Cytology revealed large, ovoid-to-polygonal, individualized and tightly cohesive epithelial cells with moderate

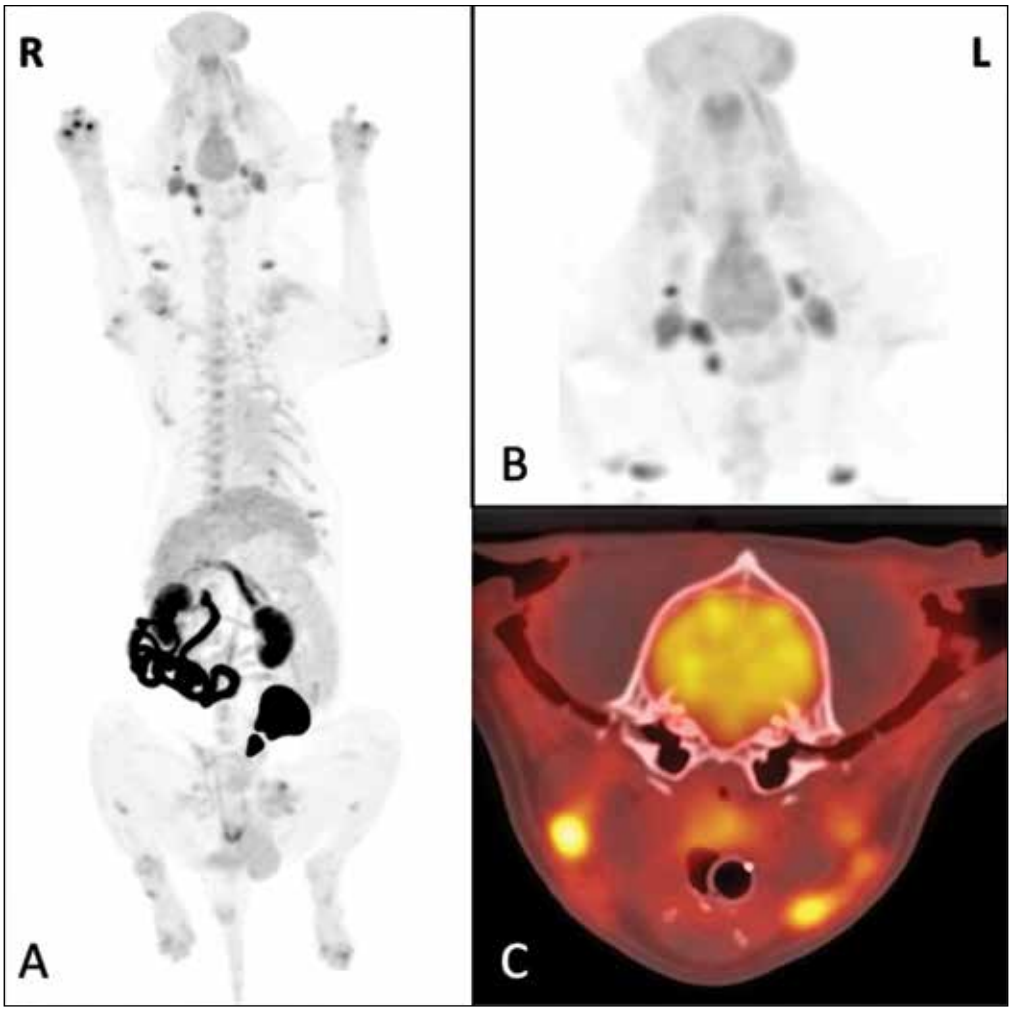

Figure 2. A – Dorsal plane whole-body grayscale positron emission tomography (PET) image. B – Magnified head dorsal plane grayscale PET image. C – Axial plane fused PET/CT at the level of the right mandibular mass resection and left mandibular lymph nodes. Note the mild to moderate increased activity in the region of the previously resected subcutaneous right mandibular neoplasm, with similar increased activity in the remaining cervical lymph nodes. Note the irregular region of right caudal cervical increased activity. The increased 2-deoxy-2-[18F]-fluorodeoxyglucose (18F-FDG) uptake in the brain, salivary tissue, and abdominal structures are normal findings. The increased activity along multiple joints is associated with osteoarthritis.

nuclear to cytoplasmic ratio, moderate anisocytosis and anisokaryosis, and frequent multinucleation, consistent with metastatic squamous cell carcinoma. Thoracic radiographs revealed no evidence of pulmonary metastasis. It was recommended that the dog be returned to the clinic in 1 wk for repeat skull, cervical, and thoracic CT scans.

Computed tomography of the skull, neck, and thorax was completed under general anesthesia. Pre- and post-contrast imaging was done using 80 mL (240 mg/mL) of iohexol administered IV. The CT imaging showed similar right mandibular soft tissue stranding and nodules in the region of the previous surgical site. Progressive enlargement of the right medial retropharyngeal, left mandibular, bilateral superficial cervical, and axillary lymph nodes was noted. The lymph node changes were concerning for progressive neoplastic or reactive lymphadenopathy. No pulmonary metastasis was identified on thoracic CT. The right mandibular soft tissues, right and left medial retropharyngeal lymph nodes, and right axillary lymph node were sampled using ultrasound guidance. Cytology of the right retropharyngeal lymph node revealed large, ovoid, individualized, tightly cohesive epithelial cells displaying anisocytosis and anisokaryosis consistent with metastatic carcinoma. Cytology of the right axillary lymph node revealed the lymphoid population to be heterogeneous and consisting primarily of small, well-differentiated lymphocytes with plasma cells frequently observed; these were most consistent with moderate plasma cell hyperplasia. Given these findings, the recommendation was for surgical removal of the affected lymph nodes followed by radiation therapy and/or chemotherapy *versus* chemotherapy alone.

The dog was presented to the Ohio State University Integrated Oncology service 175 d following initial diagnosis, for surgery. During patient preparation, the left superficial cervical lymph node was noted to be enlarged and elected for inclusion in the planned lymph node extirpation. Routine left mandibular,

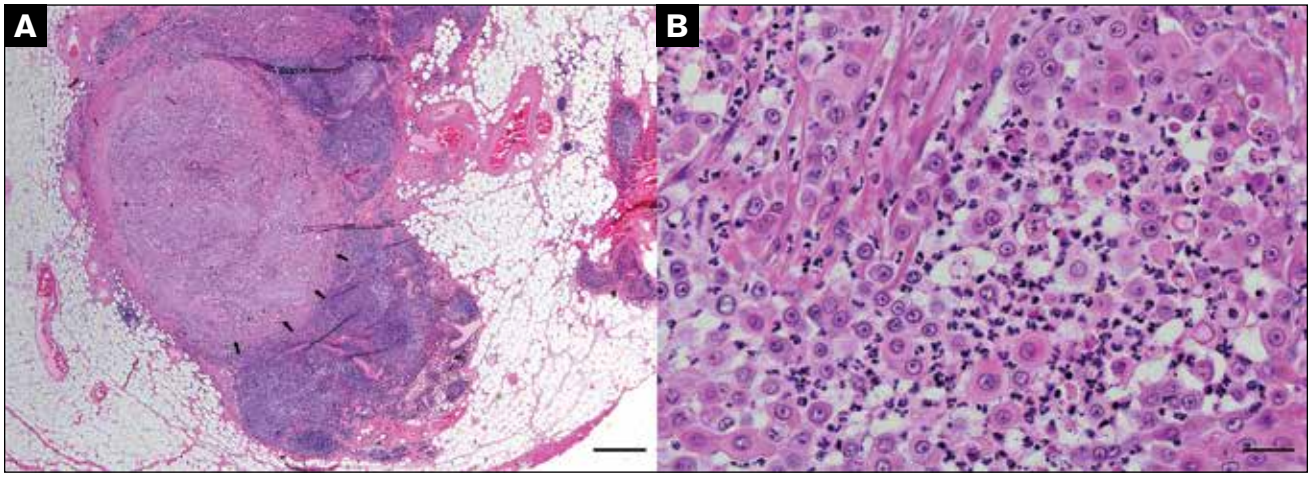

Figure 3. Histopathology. A – Light photomicrograph depicting the metastatic neoplasm expanding the subcapsular sinus and compressing the preexisting lymph node cortex (arrows). Hematoxylin and eosin, scale bar = 500 μm. B – Light photomicrograph depicting the neoplastic cell population with neutrophil infiltration. Hematoxylin and eosin, scale bar = 20 μm.

bilateral medial retropharyngeal, bilateral superficial cervical, and right deep cervical lymph node extirpations were completed. The excised lymph nodes were submitted for histopathology. The right mandibular lymph node could not be identified, though there was a significant amount of scar tissue appreciated at this site. No complications were encountered in the perioperative period and the dog recovered uneventfully. The dog received ropivacaine (1.0 mg/kg) infiltration as an incisional block and carprofen (2.2 mg/kg), SC, in recovery.

Postoperatively, the dog was monitored in the intensive care unit. The dog was managed on Plasma-Lyte (Baxter Healthcare, Deerfield, Illinois, USA) (49.6 mL/kg per day, IV); acepromazine (0.02 to 0.03 mg/kg, IV, q6h as needed); hydromorphone (0.05 mg/kg, IV, q6h); trazodone (3.6 mg/kg, PO, q8h as needed); carprofen (1.8 mg/kg, PO, q12h); cephalexin (24.3 mg/kg, PO, q12h); and Novolin N (Novo Nordisk, Princeton, New Jersey, USA) [0.75 U/kg (32 units), SC, q12h if eating]. The dog was discharged from the hospital 24 h postoperatively and recovered uneventfully.

Histopathologic evaluation of the right cranial deep cervical, right superficial cervical, right retropharyngeal, and left superficial cervical lymph nodes revealed that the cortex, medulla, and subcapsular spaces were expanded and infiltrated by a poorly demarcated, unencapsulated neoplasm. The neoplasm was composed of polygonal cells forming islands and cords supported by a variable amount of fibrous stroma (Figure 2). The neoplastic cells had 1 ovoid nucleus containing 1 to 3 prominent nucleoli, abundant eosinophilic cytoplasm, and distinct cell borders. Multinucleated neoplastic cells were frequently present. Anisokaryosis and anisocytosis were both marked. There were 21 mitotic figures per 10 400× fields present, with frequent atypical mitotic figures. Individualized round neoplastic cells and hypereosinophilic angular neoplastic cells with pyknotic nuclei were scattered within the neoplasm. Small numbers of lymphocytes and plasma cells infiltrated the neoplastic tissue. These findings were supportive of moderately differentiated metastatic carcinoma in several lymph nodes, consistent with the previously diagnosed adenosquamous carcinoma. Histopathology results for the left mandibular lymph node and left retropharyngeal lymph node revealed moderate, multifocal, lymphoid nodular hyperplasia with hemorrhage and sinus histiocytosis composed of scattered, hemosiderin-laden macrophages.

One hundred and eighty-nine days following initial presentation, cytotoxic chemotherapy was started using carboplatin (300 mg/m^2, IV *via* the left lateral saphenous vein, every 3 wk) with a plan for a total of 5 to 6 treatments. Maropitant (1.9 mg/kg, PO) was administered before each carboplatin treatment.

Two hundred and twenty-three days following initial presentation, the dog developed right thoracic limb edema. Physical examination revealed the presence of a firm, enlarged, and painful right axillary lymph node. The dog was hospitalized overnight and managed on lactated Ringer's solution (68.1 mL/kg per day, IV); methadone (0.2 mg/kg, IV, q6h as needed); gabapentin (7.2 mg/kg, PO, q8h as needed); carprofen (1.8 mg/kg, PO, q12h); maropitant (1 mg/kg, IV, q24h); and Novolin N [0.75 U/kg (32 units), SC, q12h], with a plan for CT and lymphangiogram of the right thoracic limb on the following day. Warm compressing of the limb was done q8h.

A CBC and serum biochemistry were obtained prior to the procedure. The CBC revealed a thrombocytopenia (52 K/μL; RI: 145.0 to 463.0 K/μL) and leukocytosis characterized by a mature neutrophilia [WBC: 16.95 K/μL (RI: 4.8 to 13.9 K/μL), neutrophils: 14.41 K/μL (RI: 2.6 to 10.8 K/μL)]. An elevated glucose (277 mg/dL; RI: 67 to 127 mg/dL) was noted on serum biochemistry. Computed tomography imaging of the skull, neck, forelimbs, and thorax was done under general anesthesia, using the imaging protocol initially described. Pre-contrast imaging was obtained, followed by a right forelimb lymphangiogram. Twenty milliliters (240 mg/mL) of iohexol was injected into the subcutaneous right interdigital spaces, followed by massage. Following lymphangiography, 86 mL (240 mg/mL) of iohexol was administered, IV, using a peripheral indwelling catheter for post-contrast evaluation. No lymphatic obstruction or vascular thrombus was identified to explain the cause of the thoracic limb edema. The right axillary lymph node was mildly rounded and enlarged (measuring 13 mm), with heterogenous contrast

enhancement. Although a clear cause of this acute change was not identified, switching chemotherapy agents from carboplatin to toceranib (2.6 mg/kg, PO, every other day) was recommended due to suspected progressive disease.

The dog returned 232 d following initial diagnosis for a recheck examination. Although swelling of the right thoracic limb had improved, a 7-centimeter × 4-centimeter open wound, caudal to the right elbow and extending into the subcutis, had developed. Sedated open wound management was completed every other day for 2 wk until primary wound closure could be done under general anesthesia, *via* a right thoracodorsal axial skin flap with Jackson-Pratt drain placement. Postoperatively, the dog developed a 9-centimeter area of dehiscence that was treated with open wound management until primary closure could be completed. Throughout the course of wound management, topical and oral antibiotic therapy was instituted and adjusted based on culture results.

Restaging *via* sedated skull and thoracic CT imaging was carried out 288 d following initial presentation, using the imaging protocol initially described. The right mandibular subcutaneous region remained unchanged. There was no evidence of neoplastic recurrence. A similar mild right axillary lymphadenomegaly was noted that was suspected to represent reactivity or neoplastic infiltrate. No pulmonary metastasis or intrathoracic disease was present. No treatment changes were made based on these results.

The dog was evaluated by the primary veterinarian 31 d following his last visit at the Ohio State University due to reported seizure activity. The dog was hypoglycemic and the insulin dose was decreased. The dog was euthanized 7 d later due to continued poorly controlled diabetes. No necropsy was performed. In total, the patient survived for 363 d following the initial diagnosis.

Discussion

Cancer of unknown primary origin is described as a metastatic tumor in which the site of primary origin is not identified after a complete diagnostic workup (10). Clinical presentation is variable, and patients are categorized by subgroup, ranging from poorly differentiated though highly chemosensitive carrying a more favorable prognosis to uncategorized with unpredictive metastatic potential and aggressive tendencies (4). Clinical detection of the primary tumor often does not precede detection of systemic metastasis, and clinical signs displayed due to metastasis may differ from those associated with the primary tumor (11).

In humans, > 50% of patients diagnosed with CUP will present with multiple sites of involvement, including liver, bone, lung, or lymph nodes (12). Most commonly, the primary site localizes to the lungs or within the biliopancreatic tract (3). Adenocarcinomas are the most frequently diagnosed (10). Cancer of unknown primary origin represents 3 to 5% of all human cancer diagnoses (10); however, it is sparsely reported in the veterinary literature and information regarding tumor biology, prognosis, and optimal treatment is lacking.

A study examining CUP in dogs reported a median age of 10 y at the time of diagnosis; and a majority of cases (85.7%) presented with clinical signs, such as dyspnea and lethargy, that had been present for a median of 2 wk (5). A smaller percentage (14.3%) were asymptomatic at the time of presentation (5). The few other case reports of metastatic carcinoma of unknown primary origin involve an 11-year-old, a 10-year-old, and a 9-year-old dog presenting with progressive ataxia and paraparesis of duration 1 mo, lameness and pain of duration 1 mo, and 10-day history of cough and dyspnea, respectively (6–8). Similar to reports within the human literature, Rossi *et al* (5) reported that carcinoma was the most common diagnosis (57.1%), with bone, lymph nodes, lung, and spleen as the most common metastatic sites. This case further supports the findings herein with the final diagnosis of moderately differentiated metastatic carcinoma in several lymph nodes.

Discovery of the primary tumor allows for optimization of treatment protocols, which may positively influence patient prognosis. In human medicine, cross-sectional, whole-body imaging is the gold standard, as the unknown primary mass can be located anywhere within the body, making conventional radiography and ultrasound imaging inferior (5,10). Moreover, the combination of 18F-fluorodeoxyglucose (FDG)-PET and CT has become increasingly popular, as the use of the radiotracer 2-deoxy-2-[18F]-fluorodeoxyglucose allows for detection of small lesions or pathological changes often missed on other modalities (13); its good sensitivity and specificity are most notable in diagnosing head, neck, and lung cancers (14). In humans, FDG-PET/CT detected 37% of primary lesions with sensitivity and specificity both at 84% in a previous meta-analysis (15), though detection rates of up to 53% have been reported (16,17). The use of FDG-PET/CT did not detect the primary lesion in this case, and its utility in veterinary patients remains unknown; however, an extended workup *via* PET/CT imaging should be considered when whole-body CT fails to detect the primary tumor.

The use of immunohistochemistry (IHC) to suggest primary origin has been described in the human literature. It has been reported that IHC has 35 to 40% accuracy in predicting a single primary tumor in early metastatic cancers (12), with panels of markers more effective than single biomarkers in identifying the primary site in patients with a diagnosis of adenocarcinoma (18). However, it is important to note that these studies were done in patients with known metastatic cancers *versus* those with a diagnosis of CUP. Although IHC was not used in the present case, a small number of markers have been used in dogs to determine the site of origin and differentiate metastatic carcinomas, including thyroid transcription factors-1 (TTF-1) for primary pulmonary or thyroid neoplasms and uroplakin III for urothelial neoplasms (19,20). The current recommendation is to use markers as an aid in conjunction with physical examination and imaging findings, as applicable (5).

Overall, the prognosis of human patients diagnosed with CUP is often poor, with a median survival time of 4 to 12 mo (21). Most commonly, those within the favorable subgroups are treated with locoregional treatment or systemic, platinum-based chemotherapy, whereas those within the unfavorable subgroups are treated with empirical combination chemotherapy (22,23). Rossi *et al* reported a median survival time of 30 d for all dogs diagnosed with CUP and a median survival time of 80 d for

those that underwent treatment (5). In this study, the survival time following surgery and systemic therapy with carboplatin and toceranib was 363 d. Other case studies have reported metastatic carcinoma of unknown primary origin involving the lumbar spine (6); scapula (7); and epicardium, sternal lymph nodes, and multiple lung lobes (8). In those studies, median survival times were 133 d, 737 d, and 457 d following metronomic chemotherapy with cyclophosphamide and piroxicam, amputation and adjuvant chemotherapy with doxorubicin, and piroxicam and conservative management, respectively (6–8). At present, specific diagnostic and treatment guidelines for veterinary patients diagnosed with CUP do not exist.

A limitation of the present case report is the lack of histopathological diagnosis following digit amputation 4 y prior to presentation. One differential diagnosis for this tumor would have been a digital squamous cell carcinoma (SCC). However, given the prolonged period from digital tumor removal to detection of the mandibular mass, this may be less likely to be related. Furthermore, the mandibular lymph node would not be the sentinel lymph node for the digits. Although histological examination of the initial lesion was most suggestive of metastasis within the mandibular lymph node, it was not clear whether the lymphoid proliferation associated with the tumor was representative of an enfaced lymph node or chronic lymphoplasmacytic peritumoral inflammation. Moreover, the biological behavior reported in the current case differs from previously described cases in which more widespread metastatic disease associated with shorter survival times were commonly reported. As such, additional potential differential diagnoses must include primary SCC originating from excretory ducts of the salivary glands or from remnants of the thyroglossal duct with associated severe inflammation. Another recognized limitation of this study is the lack of a necropsy following euthanasia. Although this is not mandatory in the diagnosis of CUP, further pathological studies to include sampling of the right axillary lymph node and region of the right mandibular lymph node may have been valuable.

This case report describes the clinical characteristics and treatment outcome of a dog diagnosed with metastatic CUP of several lymph nodes. Lymph node extirpation and adjuvant carboplatin and toceranib chemotherapy were performed for locoregional control. The dog survived for 363 d following the initial diagnosis. In conclusion, metastatic CUP should not be neglected as a differential diagnosis despite being a rare disease entity that is infrequently reported within the veterinary literature. Aggressive therapy combining surgery and chemotherapy can result in a long survival time.

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Case Report Rapport de cas

Outcomes following combined median sternotomy and ventral midline laparotomy for bicavitary penetrating wooden foreign bodies

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Abstract — Combined abdominal and thoracic pathology caused by extra-gastrointestinal migration of an ingested wooden foreign body (WFB) is an uncommon but serious injury. Presenting clinical signs are typically nonspecific and, in the absence of observed WFB ingestion, diagnosis is challenging. Treatment requires concurrent abdominal and thoracic surgical exploration to remove the WFB and address injuries caused by its migration. This case series describes perioperative characteristics and outcomes in 4 dogs following combined median sternotomy and ventral midline laparotomy (CMSVML) for bicavitary penetrating WFBs.

Key clinical message:
Treatment of bicavitary penetrating WFBs with CMSVML provided postoperative outcomes similar to those in previous reports; however, high-grade complications and prolonged hospitalization were commonly encountered.

Résumé — Résultats après sternotomie médiane et laparotomie médiane ventrale combinées pour des corps étrangers en bois pénétrant bicavitaires. La pathologie combinée abdominale et thoracique causée par la migration extra-gastro-intestinale d'un corps étranger en bois (WFB) ingéré est une blessure rare mais grave. Les signes cliniques présentés sont généralement non spécifiques et, en l'absence d'ingestion observée de WFB, le diagnostic est difficile. Le traitement nécessite une exploration chirurgicale abdominale et thoracique simultanée pour retirer le WFB et traiter les blessures causées par sa migration. Cette série de cas décrit les caractéristiques peropératoires et les résultats chez 4 chiens après une sternotomie médiane et une laparotomie médiane ventrale combinées (CMSVML) pour des WFB pénétrantes bicavitaires.

Message clinique clé :
Le traitement des WFB pénétrants bicavitaires avec CMSVML a fourni des résultats postopératoires similaires à ceux des rapports précédents; cependant, des complications de haut grade et une hospitalisation prolongée ont été fréquemment rencontrées.

(Traduit par Dr Serge Messier)

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Penetrating wooden foreign bodies (WFBs) are usually encountered as oropharyngeal injuries in dogs (1–3). However, intracavitary WFBs from external penetration or gastrointestinal (GI) tract migration have been reported with injuries to the heart, vasculature, lungs, liver, GI tract, urinary tract, and spinal cord (4–10). In addition to the risk of fragmentation and bacterial inoculation, intracavitary WFBs have the potential to migrate, causing further tissue damage, which demonstrates the importance of prompt diagnosis and treatment (6,11,12). Ingested WFBs have potential to traumatize both the thoracic and abdominal cavities after extraluminal GI migration, requiring surgical exploration of both cavities concurrently (6,7,10,11).

Diagnosing penetrating WFBs can be difficult, especially when ingestion of the WFB is not observed. Presurgical recognition of the extent of injuries and surgical intervention required is critical to successful management of these cases (6,13,14). Orthogonal radiographs have low sensitivity in detecting WFBs (2,13). Compared to other modalities, computed tomography (CT) has been reported as the most accurate imaging modality for detecting WFBs (2,7,11,13,15).

In humans requiring combined thoracotomy and laparotomy for penetrating thoracoabdominal injuries, a higher mortality

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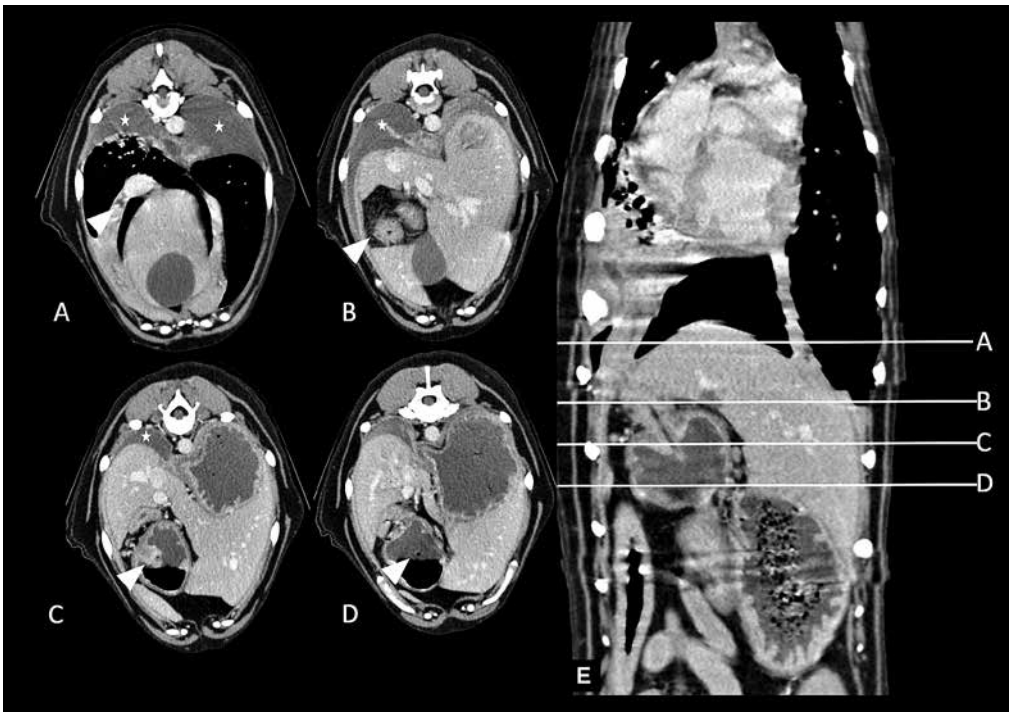

Figure 1. Transverse plane (A to D) and dorsal plane (E) computed tomographic images of Dog 1, showing a wooden foreign body (arrowhead) extending from the right caudal pleural space into the abdomen and stomach. There is moderate pleural effusion (star) in the dorsal pleural space.

rate has been reported when compared to single-cavity injuries (15). This is likely due more to the severity of injuries sustained than to the required dual-cavity surgical approach. Survival-to-discharge rates have been reported to be high, but prolonged hospitalization is common in both humans and dogs (6,11,16–20). The purpose of this case series is to describe perioperative characteristics and outcomes in 4 dogs following combined median sternotomy and ventral midline laparotomy (CMSVML) for ingested bicavitary penetrating WFBs.

Case descriptions

Medical records of dogs diagnosed with penetrating WFBs that underwent CMSVML at the Ontario Veterinary College (Guelph, Ontario) between 2014 and 2021 were retrospectively reviewed. Bicavitary penetrating injury was defined as any tissue damage in both the thorax and abdomen and connected by a diaphragmatic defect caused by penetrating WFBs identified on CT imaging and/or at the time of surgery. Four dogs [2 males, 2 females; median age: 2.5 y (range: 0.5 to 11 y); median weight: 19.4 kg (range: 5.5 to 25.2 kg)] met inclusion criteria. Breeds were 1 each of labradoodle, west Highland white terrier, husky, and Alaskan malamute. Median time-to-presentation was 4 d (range: 3 to 21 d). Two dogs were historically observed to consume wooden skewers. Clinical signs and physical examination findings included lethargy (n = 4), hyporexia or anorexia (n = 3), tachypnea (n = 3), increased respiratory effort (n = 3), abdominal pain (n = 2), vomiting (n = 3), and pyrexia (n = 2). Survey thoracic or abdominal radiographs did not identify a WFB in any dog; however, CT under general anesthesia identified a WFB in 3 dogs (Figure 1). In Dog 3, a WFB was not identified on CT, but concurrent imaging findings, including

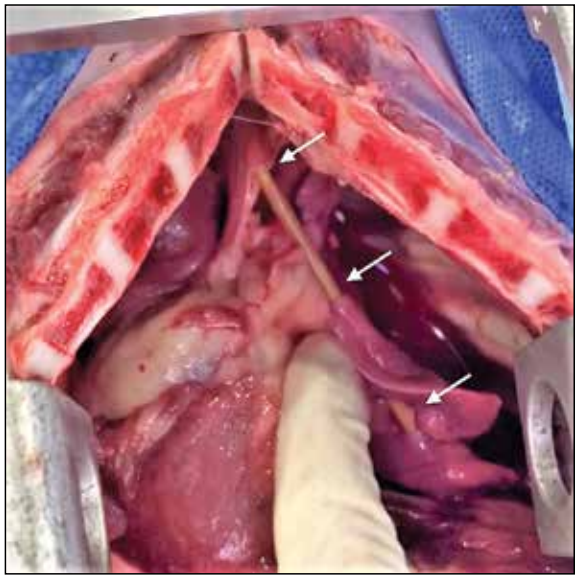

Figure 2. Intraoperative image from a median sternotomy in Dog 2, showing a wooden skewer (arrows) penetrating through the stomach (middle arrow) and diaphragam (top arrow). This wooden skewer was found to have injured the left caudal and caudal subsegment of the left cranial lung lobe.

pulmonary heterogenicity and suspect visceral pleural damage, marked cellulitis and pleuritis at the level of the 8th rib, and a linear tract in the right lateral liver lobe with small adjacent peritoneal gas bubbles, supported the presence of a migrating WFB.

All dogs were taken for exploratory surgery where a CMSVML was done, with ventral midline laparotomy completed prior to median sternotomy in 3 dogs. In Dog 3, a median sternotomy was done first due to severe pneumothorax

Table 1. Origin and location of wooden foreign body (WFB), surgical procedures completed, and outcome in each dog undergoing combined median sternotomy and ventral midline laparotomy.

Dog	Origin & location of WFB	Diaphragmatic herniorrhaphy	Thoracic surgical procedures	Abdominal surgical procedures	Survived
1	Gastric: Extending ~16 cm cranially from the gastric lumen to right caudal lung lobe.	No	Complete lobectomy of the right cranial and right middle lung lobes. Partial lobectomy of the right caudal lung lobe.	Gastric perforation repair.	Yes
2	Gastric: Extending ~11.5 cm cranially from the gastric lumen to the left cranial lung lobe.	Yes	Partial lung lobectomy of the caudal subsegment of the left cranial lung lobe. Complete left caudal lung lobectomy.	Gastric perforation repair. L3/L4 epaxial abscess drainage and exploration.	Yes
3	Gastric: Extending cranially from the gastric lumen to the left cranial lung lobe.	Yes	Complete lung lobectomy of the left caudal, accessory, and right middle lobes. Partial lung lobectomy of the caudal subsegment of the left cranial lobe.	Gastric perforation repair.	No
4	Gastric: Extending ~15.5 cm cranially and dorsolaterally from the gastric lumen to the subcutaneous tissue at the level of the 11th rib.	Yes	Complete lung lobectomy of the left caudal lung lobe. Lateral thoracic granuloma debridement.	Gastric perforation repair.	Yes

Table 2. Types, frequencies, and grades of Veterinary Cooperative Oncology Group – Common Terminology Criteria for Adverse Events (VCOG-CTCAE v2) complications encountered in the intraoperative, early postoperative (prior to discharge), and late postoperative (after discharge) periods.

	VCOG-CTCAE v2 complication grade				
Interval	1	2	3	4	5
Intraoperative complications	Regurgitation (1)	Hypotension (2) Hypoxia (1)	Hypotension (2) Hypothermia (2)		
Early postoperative complications	Regurgitation (1)			Hypovolemia (1) Dyspnea (1) Hypoxemia (1) Pneumothorax (1)	
Late postoperative complications		Surgical site infection (1)			

and respiratory decompensation. In Dog 1, thoracoscopic evaluation was completed prior to median sternotomy. A WFB was identified and removed in all cases (Figure 2). Surgical procedures are summarized for each dog (Table 1). Multiple lung lobectomies were required in all dogs. Partial and/or complete lung lobectomy was done using a TA30V (Medtronic, Minneapolis, Minnesota, USA) or Endo GIA (Medtronic) stapling device. The thoracic and abdominal cavities were flushed copiously with sterile saline prior to placement of unilateral (n = 3) or bilateral (n = 1) thoracic drainage catheters (MILA International, Florence, Kentucky, USA) and closed-suction abdominal drains (n = 2) (Cardinal Health, Dublin, Ohio, USA). Dog 4 required repositioning for exploration and debridement of a right lateral thoracic granuloma that communicated with the thoracic cavity, suspected to be due to migration of the WFB. Median surgical anesthesia time was divided, as 3 dogs underwent a separate general anesthesia for CT imaging on the day before surgery [median: 225 min (range: 195 to 285 min)], whereas 1 dog went straight from CT to surgery (315 min).

Intraoperative, early postoperative (before discharge), and late postoperative (after discharge) complications were graded on a scale of 1 (mild clinical signs) to 5 (death) using the Veterinary Cooperative Oncology Group — Common Terminology Criteria for Adverse Events (VCOG-CTCAE v2) (21). Long-term outcomes were obtained *via* an online survey sent to referring veterinarians. Complications encountered are outlined in Table 2. A pneumothorax (grade 4) developed in Dog 3 in the early postoperative period, requiring continuous pleural suction and positive pressure ventilation. This dog also experienced dyspnea and hypoxemia upon anesthetic recovery, precluding extubation and requiring continuous positive pressure ventilation and pleural suction. This dog also had severe hypovolemia intractable to vasopressor support and plasma transfusion. Euthanasia was elected ~6 h after surgery due to a poor prognosis. The remaining 3 dogs were discharged from hospital with a median time-to-discharge of 6 d (range: 4 to 9 d). Long-term follow-up was available in 2 dogs (at 16 and 20 mo, respectively). Both were alive at the time of writing, and full recovery and excellent owner satisfaction were reported. One dog was lost to follow-up after the 14-day suture removal appointment.

Discussion

Penetrating WFBs represent challenging cases because of the potential for bicavitary injuries that often involve multiple organs or tissues, and they can be unpredictable given the possibility for

WFB migration (4–10). In this case series, CMSVML allowed for detailed exploration of thoracoabdominal cavities as well as debridement and repair of traumatized tissues. Although CMSVML resulted in prolonged postoperative hospitalization, dogs can have excellent long-term outcomes. This was consistent with results in humans, where CMSVML was a safe and effective surgical approach for management of thoracoabdominal pathology (17,18).

In the present case series, 3 dogs underwent ventral midline laparotomy prior to median sternotomy. However, median sternotomy was prioritized in Dog 3 due to a severe pneumothorax and respiratory decompensation. This dog was euthanized in the early postoperative period. Mortality does not appear to have been related to inappropriate surgical sequencing, as only minor injuries were noted in the abdomen. Published data on the sequence of surgical procedures for penetrating thoracoabdominal injuries in humans showed inappropriate sequencing, defined as the need to interrupt one procedure and convert to another, in nearly 1/2 of patients (16). However, a standardized sequencing recommendation would be inappropriate in dogs with bicavitary WFBs, as the injuries and clinical status of the individual dog can be highly variable, as in this and other previous reports (4–10).

Lung lobectomy using a stapling device was the most common surgical procedure in this case series. Stapling devices are a secure and efficient technique for complete and partial lung lobectomies, with low reported complication rates in both veterinary and human medicine (22,23). Dog 3 in this case series developed a persistent pneumothorax postoperatively (22,24). It is unknown if this complication was due to failure of a stapling device in occluding a bronchus, a missed laceration, or a missed abscess in one of the remaining lung lobes. This dog required extensive lung lobectomies approximating at least 50% of total lung volume due to extensive abscessation and lacerations (Table 1). Although not lateralized, this degree of lung volume resection is similar to a pneumonectomy, which has been reported to carry high morbidity and mortality rates in dogs (25,26). Right pneumonectomy, accounting for 58% of lung volume, can be tolerated in healthy dogs and those with chronic progressive disease, as the remaining lung volume can compensate (25–28). In Dog 3, insufficient residual healthy lung tissue to compensate for the removed lung volume likely led to respiratory failure and subsequent euthanasia.

Survey thoracic or abdominal radiography, a common first-line diagnostic approach for primary or urgent care veterinarians, has been reported to have a very low positive predictive value in identifying WFBs (13,14). None of the WFBs in our case series were identified on radiographs. In comparison, CT has been reported as the most accurate modality for WFB detection, with a sensitivity and specificity of 79 and 93%, respectively (2,12,15). However, varying wood densities and the degree of body fluid absorption once *in situ* result in a wide range of possible attenuation on CT, which can make identification challenging (9,12). In addition, CT findings of acute WFBs often mimic gas due to their porous composition, whereas chronic, hydrated WFBs appear similar to soft tissue (7,9,15). The hallmark finding in acute cases tends to be soft tissue emphysema, whereas chronic cases present with draining sinuses, cavitary lesions, fat stranding, and periosteal reactions on adjacent bones (12). Furthermore, WFBs are identified on CT imaging more commonly in chronic cases in both veterinary and human medicine (9,12).

The VCOG-CTCAE v2 scheme was chosen to report both intraoperative and postoperative complications. A need for standardized adverse event (AE) reporting in veterinary medicine, to allow meaningful comparison across studies, has been identified (29). The VCOG-CTCAE v2 scheme was chosen as it was formulated to provide standardized definitions and specific grading criteria for individual AEs, reducing the extent of subjective judgements (19).

Long-term survival rates for dogs with bicavitary WFBs who underwent CMSVML are limited to a subset population of 11 dogs in 3 retrospective studies. Ten dogs survived to discharge (6,10,11). In our case series, similar outcomes were observed. Two dogs with long-term follow-up were reported to achieve excellent outcomes.

Limitations of this study include its retrospective nature, small sample size, and selection bias. Data were retrieved from medical records and multiple clinicians were involved in the management of these cases.

In conclusion, acceptable outcomes can be achieved following CMSVML for bicavitary penetrating WFBs. As considerable morbidity is expected, these cases may be best managed at referral hospitals with specialist care.

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Case Report Rapport de cas

Ultrasonographic findings of multicentric malignant lymphoma involving the urinary bladder in a dog: Diagnosis and monitoring during chemotherapy

Antonin Martenne-Duplan, Cindy Chervier, Marlène Finck

Abstract — A 5.5-year-old spayed female cane corso dog was presented for recurrent hematuria and dysuria. Abdominal ultrasound demonstrated severe hypoechoic urinary bladder wall thickening with irregular mucosal surface and polypoid-like lesions protruding into the lumen, abdominal polyadenomegaly, and splenic honeycombing. High-grade lymphoma was diagnosed on urinary bladder wall cytology. Clinical signs and ultrasonographic findings initially improved following a modified CHOP-based chemotherapy protocol, but the multicentric lymphoma then progressed with thoracic spread, leading to the dog's death at 9 wk post-diagnosis.

Key clinical message:
This case report describes the ultrasonographic features of malignant lymphomatous infiltration of the urinary bladder and emphasizes the importance of including lymphoma in the differential diagnosis for parietal urinary bladder lesions. It also describes the endoscopic findings of such an infiltration that have not yet, to the authors' knowledge, been described or illustrated in the veterinary literature. Finally, this case report underlines the poor prognosis of multicentric lymphoma involving the urinary bladder, with rapid progression of the disease and short survival time despite chemotherapy.

Résumé — Résultats échographiques d'un lymphome malin multicentrique impliquant la vessie chez un chien : diagnostic et surveillance pendant la chimiothérapie. Une chienne cane corso stérilisée âgée de 5,5 ans a été présentée pour une hématurie et une dysurie récurrentes. L'échographie abdominale a démontré un épaississement hypoéchogène sévère de la paroi de la vessie avec une surface muqueuse irrégulière et des lésions de type polypoïde faisant saillie dans la lumière, une polyadénomégalie abdominale et une rate avec apparence en nid d'abeille. Un lymphome de grade élevé a été diagnostiqué sur la base de la cytologie de la paroi de la vessie. Les signes cliniques et les résultats échographiques se sont initialement améliorés après un protocole de chimiothérapie à base de CHOP modifié, mais le lymphome multicentrique a ensuite progressé avec une propagation thoracique, entraînant la mort du chien à 9 semaines après le diagnostic.

Message clinique clé :
Ce rapport de cas décrit les caractéristiques échographiques de l'infiltration lymphomateuse maligne de la vessie et souligne l'importance d'inclure le lymphome dans le diagnostic différentiel des lésions pariétales de la vessie. Il décrit également les résultats endoscopiques d'une telle infiltration qui n'ont pas encore, à la connaissance des auteurs, été décrits ou illustrés dans la littérature vétérinaire. Enfin, ce rapport de cas souligne le mauvais pronostic du lymphome multicentrique impliquant la vessie, avec une progression rapide de la maladie et une courte durée de survie malgré la chimiothérapie.

(Traduit par Dr Serge Messier)

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Case description

Signalment, history, and clinical findings

A 5.5-year-old spayed female cane corso dog was presented to the referral hospital (Centre Hospitalier Vétérinaire Massilia; Marseille, France) with a 6-week history of persistent dysuria and hematuria and unresponsiveness to multiple antibiotic and nonsteroidal anti-inflammatory treatments. A few episodes of vomiting were also reported during this period. Repeatable caudal abdominal pain was elicited on abdominal palpation. Peripheral lymph nodes (mandibular, prescapular, and popliteal) were mildly enlarged and indurated on physical examination. A complete blood (cell) count (CBC) at the time of presentation indicated a moderate neutrophilic leukocytosis ($19.6 \times 10^3/\mu L$ WBC, $15.2 \times 10^3/\mu L$ neutrophils). However, a serum chemistry panel was within the normal range. Urine sediment analysis revealed hematuria, and *Klebsiella pneumoniae* was isolated on urinary bacteriology.

Before presentation, the dog had undergone surgery for gastric dilatation-volvulus 1 y earlier and surgical repair of a right cranial cruciate ligament rupture 4 y earlier. No other medical concern was reported.

Imaging findings and diagnosis

Abdominal ultrasonographic examination (Aplio a-series, convex and microconvex multifrequency transducers between 3 and 11 MHz; Canon Medical Systems France, Suresnes, France) revealed severe urinary bladder wall thickening with irregular mucosal surface and broad-based, polypoid-like lesions protruding into the lumen (Figure 1 A, B). There was decreased echogenicity of the urinary bladder wall, with loss of its layered ultrasonographic structure. The entire urinary bladder wall, including trigone and proximal urethra, were affected. The urinary bladder lumen was almost nonexistent. The spleen was enlarged with a honeycombing pattern. Several abdominal lymph nodes were rounded and severely enlarged, from 11.9 to 31.0 mm thick, with markedly decreased echogenicity. Kidneys and ureters were within normal limits and hepatic size and echogenicity were normal. No other anomaly was noted on abdominal ultrasound on that day. No abnormality was detected on 3-view thoracic radiographs.

Ultrasonographic-guided fine-needle aspirates of the urinary bladder wall, spleen, liver, and left medial iliac lymph node were performed using a 22G needle.

Endoscopic examination (URF-V Video-uretero-renoscope, external diameter 3.3 mm, length 670 mm, operator canal 1.2 mm; Olympus France, Rungis, France) of the lower urinary tract showed marked diffuse thickening and irregularities of both vesical and urethral walls, with polypoid-like lesions on the bladder wall (Figure 2 A, B). Vesical and urethral mucosa were heterogeneous with multifocal erythematous areas. The urinary bladder lumen was severely decreased in volume. Partial-thickness endoscopic bladder biopsies were carried out.

Urinary bladder wall, splenic, and left medial iliac lymph node cytology revealed high-grade lymphoma. However, hepatic cytology did not show any lymphomatous infiltration. Urinary bladder wall histology was inconclusive due to small sample size and crushing artifact. However, a small, round cell population was suspected within an epithelial surface. Although this finding may support the diagnosis of urinary bladder lymphoma, it cannot confirm it.

Therapy and outcome

Treatment was a modified CHOP-based chemotherapy protocol (Table 1). Complete physical examination and ultrasonographic monitoring of the urinary bladder and other abdominal structures were performed at each chemotherapy session to assess therapeutic responses of the peripheral lymph nodes and abdominal organs.

Based on RECIST criteria, partial response was defined as at least 30% reduction of nodal/urinary bladder wall thickness, progressive disease as at least 20% increase of nodal/urinary bladder wall thickness, and stable disease if neither a progressive disease nor partial response was observed (1).

At each chemotherapy session, a CBC was obtained to assess for evidence of chemotherapy toxicity. If the dog presented with neutropenia ($< 2.0 \times 10^3/\mu L$), treatment was delayed until the WBC count came back into the normal range. If so, broad-spectrum antibiotic treatment (amoxicillin, clavulanic acid) at standard doses was given, PO, for 5 to 7 d. The dog received prednisolone at an initial dosage of 1 mg/kg, PO, q24h; tapering to 0.5 mg/kg, PO, q24h over 4 wk; and then increased to 0.75 mg/kg, PO, q24h during progression of the disease until death. If needed, antinauseant (maropitant, 2 mg/kg, PO, q24h) or antidiarrheic (diosmectite, 0.15 mg/kg, PO, q12h) treatments were added.

On the week of diagnosis (Week 1), the patient received vincristine (Oncovin; Vidal France, Issy-les-Moulineaux, France), 0.7 mg/m^2, IV.

On Week 2, after 1 chemotherapy injection, there was evidence of partial response. There were marked decreases in peripheral lymph node sizes and urinary bladder wall thickness, with resolution of the splenomegaly, but persisting mild splenic parenchymal heterogeneity on ultrasonographic examination (Table 2 and Figure 3 A). The owner reported improved urinary signs. One dose of vincristine was administered on this day.

On Week 3, there was partial response to chemotherapy treatment associated with normalization of both peripheral and abdominal lymph node sizes, splenic size and parenchymal homogeneity, and urinary bladder wall thickness, with an improved vesical repletion. However, there were persisting multifocal irregularities of the bladder wall mucosal layer (Table 2). The owner reported resolution of urinary clinical signs. One dose of vincristine was administered.

On Week 4, stable disease was observed, with persistence of mild, multifocal mucosal irregularities within the urinary bladder wall, which was otherwise normal in thickness on ultrasound (Table 2 and Figure 3 B). The 4th dose of vincristine was administered.

On Week 5, the chemotherapy injection was delayed due to severe neutropenia, and antibiotic therapy was initiated PO. The owner went away on vacation with her dog for 2 wk, before the 5th injection could be administered. No biological or imaging follow-up was done during these 2 wk.

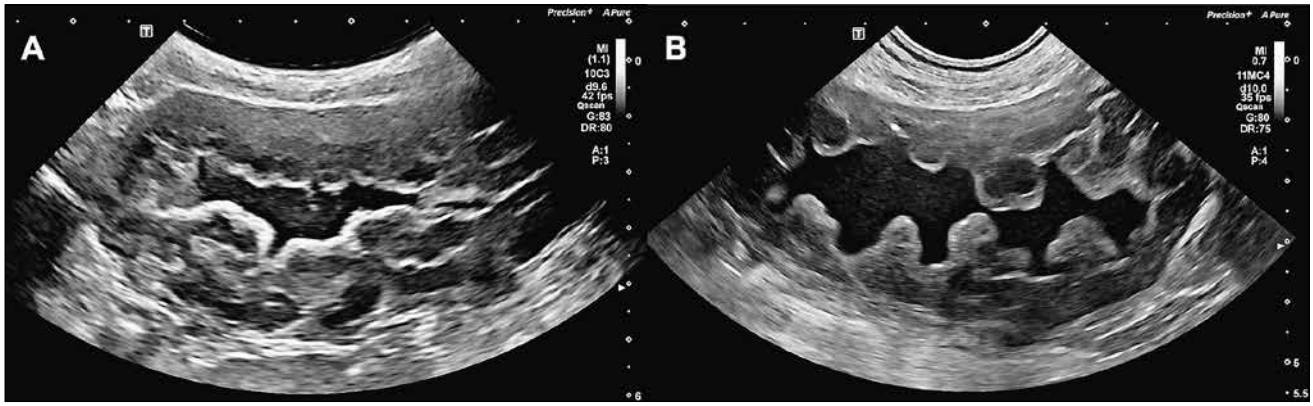

Figure 1. Longitudinal (A) and transversal (B) axis ultrasound images of the urinary bladder on the day of presentation, acquired with convex and microconvex transducers (3 to 11 MHz) with the dog in dorsal recumbency. The urinary bladder wall is severely thickened, with irregular mucosal surface and broad-based hypoechoic, polypoid-like lesions protruding into the lumen, with loss of its layered ultrasonographic structure. The urinary bladder lumen is severely decreased.

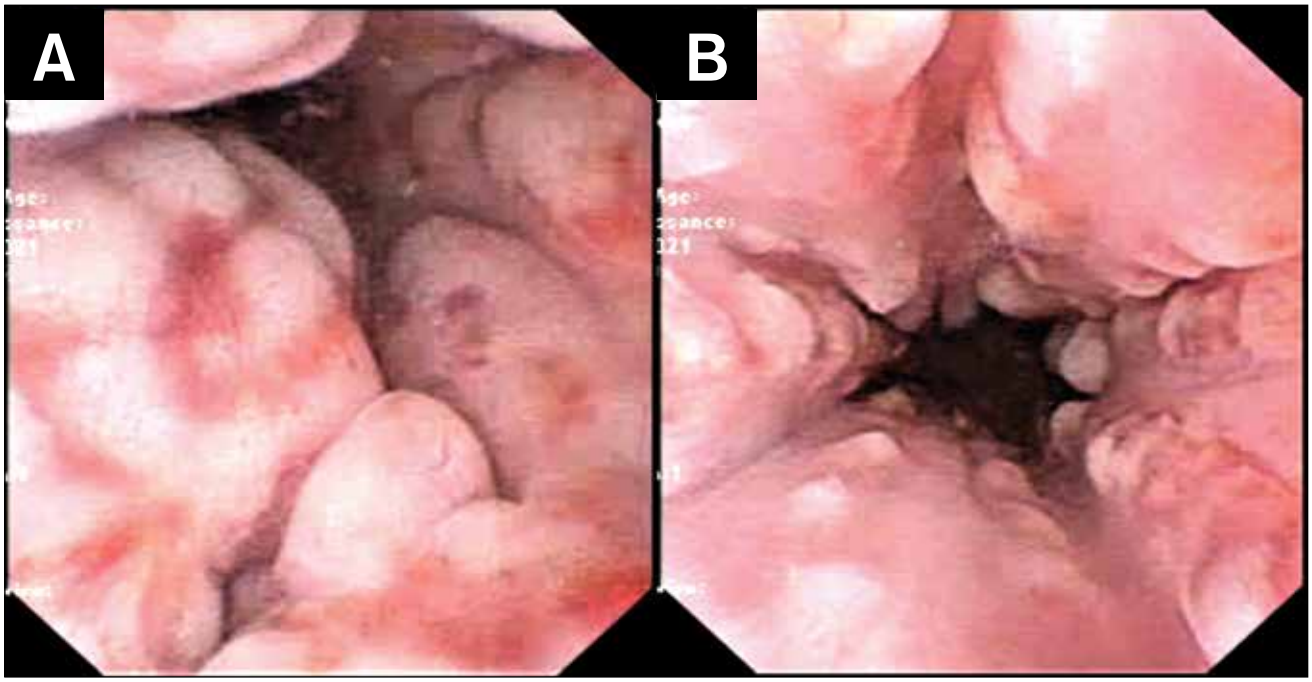

Figure 2. Cystoscopic views of the urinary bladder (A) and the urethra (B) of a dog in a caudo-cranial orientation. The urinary bladder and urethral walls are markedly thickened with polypoid-like lesions. The mucosa is heterogeneous with multifocal erythematous areas.

On Week 7, progression of the disease was observed, with mild-to-moderate enlargement of several peripheral lymph nodes detected at physical examination. Ultrasonographic examination showed recurrence of urinary bladder wall thickening, with severe mucosal irregularities and loss of vesical repletion, abdominal polyadenomegaly, and splenomegaly (Table 2). The owner had not reported any recurrence of urinary clinical symptoms since the previous consultation. An injection of vincristine was administered, with an additional administration of cyclophosphamide (Endoxan; Vidal), 130 mg/m^2, PO, due to progressive disease.

On Week 8, clinical and ultrasonographic findings were stable, with no significant signs of disease progression (Table 2). The owner reported an intermittent cough had started 1 d before the consultation. Doxorubicin (Doxorubicine; Teva Santé, Courbevoie, France), 30 mg/m^2, IV, was administered.

Table 1. Chart of modified CHOP-based treatment protocol for treating a dog with multicentric malignant lymphoma involving the urinary bladder.

Week	Drug (dose and route of administration)
1	L-asparaginase (400 IU/kg, IM)
2	Vincristine (0.7 mg/m^2, IV)
3	Vincristine (0.7 mg/m^2, IV)
4	Vincristine (0.7 mg/m^2, IV)
5	Vincristine (0.6 mg/m^2, IV) + cyclophosphamide (200 mg/m^2, PO)
8	Doxorubicin (30 mg/m^2, IV)
11	Vincristine (0.7 mg/m^2, IV) + cyclophosphamide (200 mg/m^2, PO)

Repetition of protocol for Weeks 8 and 11 every 3 wk until a maximum of 6 doses of Doxorubicin were injected

During the management of this case, L-asparaginase was out of stock in the country. This led to the decision to start the chemotherapy protocol directly with vincristine. In this case, the protocol of Week 5 was delayed to Week 7 due to biological evidence of chemotherapy toxicity at Week 5, and because the owner went on vacation for 2 wk. Doxorubicin was administered 1 wk later (Week 8) due to disease progression.

Table 2. Ultrasonographic evolution and monitoring of abdominal lesions during modified CHOP-based chemotherapy in a case of multicentric lymphoma involving the urinary bladder wall in a dog.

Week	Change in the sum of all abdominal lesions (%)	Lymph nodes thickness (mm)	Mean urinary bladder wall thickness (mm)	Splenomegaly/splenic parenchymal homogeneity
1	Not applicable	11.9 to 31.0	10.6	Present/honeycombing pattern
2	−42	6.1 to 16.2	6.2	Absent/mild mottled pattern
3	−37.5	4.2 to 10.1	5.5	Absent/homogeneous
4	−12	4.1 to 9.4	3.7	Absent/homogeneous
Temporary interruption of chemotherapy treatment and monitoring				
7	+198	19.1 to 28.4	12.2	Present/moderate mottled pattern
8	+17.5	19.3 to 29.5	13.5	Present/honeycombing pattern
9	+145	32.6 to 43.2	13.2	Present/honeycombing pattern

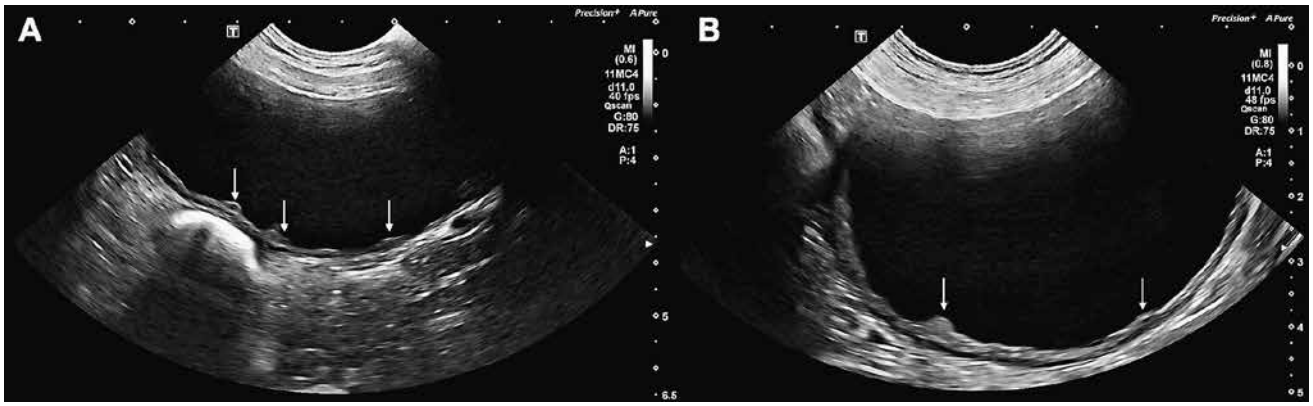

Figure 3. Transversal axis ultrasound images of the urinary bladder 1 wk (A) and 3 wk (B) after onset of chemotherapy. Images were acquired with a microconvex transducer (4 to 11 MHz) with the dog in dorsal recumbency. The urinary bladder wall thickness is within normal limits. There are discrete, multifocal, mucosal irregularities (white arrows), but the layered ultrasonographic structure is restored. The urinary bladder luminal filling is within normal limits.

On Week 9, the dog was presented for hematuria, hyperthermia, vomiting, diarrhea, and lethargy. On physical examination, signs of progressive disease were present, with severe peripheral lymphadenomegaly. The CBC showed severe neutrophilic leukocytosis (40 300 × $10^3/\mu L$). Ultrasonographic examination showed dramatic worsening of urinary bladder wall infiltration and markedly increased size and number of abdominal lymph nodes, with mild peritoneal effusion (Table 2). Thoracic radiographs showed severe cranial mediastinal and tracheobronchial lymphadenomegaly, compatible with malignant lymphoma progression. Following deterioration of her general condition, the dog died of sudden cardiorespiratory arrest during hospitalization at 9 wk after initial diagnosis and initiation of chemotherapy.

Discussion

We describe here a "non-localized lymphoma." This is a rarely reported form of malignant, multicentric lymphoma affecting the urinary bladder, in which lymphomatous infiltration of the bladder occurs as a manifestation of systemic lymphoma. This type of malignant, multicentric lymphoma affecting the urinary bladder must not be confused with extranodal malignant lymphoma affecting the urinary bladder. In humans, primary extranodal lymphoma of the urinary bladder is defined as a malignant lymphoma limited to the urinary bladder, with no other organs affected and no previous history of lymphoma. Extranodal malignant lymphoma does not primarily affect the lymphatic organs. The most common sites described in dogs and cats are primary lymphoma of the gastrointestinal system, kidneys, nasal cavity, central nervous system, eyes, and skin (2). Other sites for extranodal primary malignant lymphomas have rarely been reported in veterinary medicine. Their biological behavior and response to therapy are even less well-known. Only a few cases are reported in the veterinary literature (2–7). Malignant, multicentric lymphoma affecting the urinary bladder must also be differentiated from "secondary lymphoma," which corresponds to recurrence of malignant lymphoma within the urinary bladder after initial successful treatment (8,9).

In the veterinary literature, there are only 6 canine and 3 feline case reports of malignant lymphoma involving the urinary bladder, without any clear distinctions among primary, secondary, or non-localized lymphoma regarding ultrasonographic findings or medical management (3–7).

In humans, multicentric and secondary lymphomas represent most cases with urinary bladder involvement. Based on autopsy studies, 10 to 20% of those with non-Hodgkin's lymphoma ultimately develop secondary bladder involvement (9,10). Conversely, primary urinary bladder lymphoma is extremely rare and represents $<$ 1% of vesical tumors and 0.2% of all extranodal lymphomas (8,9,11).

The age range of affected dogs and cats described in the veterinary literature was between 2 and 7 y (5–7). All reported cases, including the present case, presented for gross hematuria, which is also the main complaint in human patients. Radiographic

and ultrasonographic characteristics in dogs with lymphoma involving the urinary bladder cannot differentiate them from other urinary bladder neoplasms and thus cannot be used to make a presumptive diagnosis of malignant lymphoma (6). Reported ultrasonographic appearances of urinary bladder lymphomatous infiltration in the veterinary literature range from a homogeneous, smooth-margined mass (12) to large, heterogeneous, lobular masses or bladder wall thickening (5). Lymphoma can affect any part or layer of the urinary bladder wall and, due to limited reports in the veterinary literature, it is not possible to determine whether there is a predilection location for urinary bladder lymphoma. In humans, contrast computed tomography and magnetic resonance imaging are considered imaging modalities of choice for accurate bladder tumor differentiation and tumor staging (13,14).

To the authors' knowledge, urinary bladder lymphoma in the dog has not been illustrated with cystoscopic images in the veterinary literature. Here, endoscopic examination was complementary to ultrasound and facilitated biopsy retrieval.

In a 3-year-old female dog with primary urinary bladder malignant lymphoma, chemotherapy and radiotherapy resulted in rapid and complete remission of the tumor (7). However, there is apparently no report in the veterinary literature detailing a specific chemotherapy protocol for multicentric lymphoma involving the urinary bladder. The multi-agent, CHOP-based chemotherapy protocol has been considered the "gold standard" chemotherapy treatment for dogs with multicentric lymphoma since its introduction in the early 1990s (15). Each drug in this protocol uses a different mechanism to kill malignant lymphomatous tumoral cells. The drugs are alternated to reduce early side effects and to prevent or delay the appearance of lymphoma cell resistance to chemotherapy molecules. This CHOP-based protocol can be modified due to financial limitations, specific medical considerations, or clinician discretion, based on the literature and clinical experience. Remission rates of CHOP-based protocols are $\geq$ 85%. However, most dogs that reach remission following a CHOP-based protocol will eventually relapse, with $<$ 25% of patients exceeding a 2-year survival time, and a large number of factors influencing the prognosis (16).

In this case, survival for 9 wk was far below the reported rate for multicentric lymphoma but was in agreement with other case reports of multicentric lymphoma involving the urinary bladder that also involved short survival times. Here, progression of the disease occurred after a 3-week treatment interruption. CVJ

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Case Report Rapport de cas

Anal sac mast cell tumor in a dog

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Abstract — An 11-year-old castrated mixed-breed dog was diagnosed with a unilateral anal sac mass. Anal sacculectomy was performed without complication. Histopathology of the mass was consistent with a well-differentiated mast cell tumor. Analyses for the Ki-67 protein, KIT expression pattern, and the presence of *c-kit* mutations were done. Recovery from surgery was unremarkable and repeat staging revealed no evidence of mast cell disease at 4, 8, and 12 mo after surgery. To the authors' knowledge, primary mast cell neoplasia of the anal sac has not previously been reported in the veterinary literature.

Key clinical message:
Although mast cell tumors of the perineal region are commonly encountered in veterinary practice, the anal sac represents a novel location for this disease. Cytology of anal sac masses can be a useful diagnostic tool to confirm the diagnosis, guide staging, and assist in treatment decisions.

Résumé — Tumeur mastocytaire du sac anal chez un chien. Un chien de race mixte castré âgé de 11 ans a reçu un diagnostic de masse unilatérale du sac anal. La sacculectomie anale a été réalisée sans complication. L'histopathologie de la masse était compatible avec une tumeur mastocytaire bien différenciée. Des analyses de la protéine Ki-67, du modèle d'expression KIT et de la présence de mutations *c-kit* ont été effectuées. La récupération après la chirurgie était sans particularité et la répétition de la stadification n'a révélé aucun signe de maladie mastocytaire à 4, 8 et 12 mois après la chirurgie. À la connaissance des auteurs, la néoplasie primitive des mastocytes du sac anal n'a pas été signalée auparavant dans la littérature vétérinaire.

Message clinique clé :
Bien que les tumeurs mastocytaires de la région périnéale soient couramment rencontrées en pratique vétérinaire, le sac anal représente une nouvelle localisation pour cette maladie. La cytologie des masses du sac anal peut être un outil de diagnostic utile pour confirmer le diagnostic, guider la stadification et aider aux décisions de traitement.

(Traduit par Dr Serge Messier)

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Apocrine gland anal sac adenocarcinoma (AGASACA) is the most common neoplasm of the canine anal sac. These tumors can show aggressive biologic activity and readily metastasize to locoregional lymph nodes. Additionally, distant metastasis and paraneoplastic hypercalcemia often occur with AGASACA, which can affect both the prognosis and the approach to surgical and medical management (1). Therefore, complete staging before surgical intervention is recommended to assess for the presence of metastasis, hypercalcemia, and comorbidities. Cutaneous mast cell tumors (cMCTs) are the most frequently diagnosed cutaneous neoplasms in the dog, with most of these tumors located on the trunk, perineum, limbs, head, and neck (2). Surgery remains the mainstay of therapy for solitary cMCTs when feasible and clinically appropriate. Tumor location may affect prognosis and clinical case management (2–6). To date, mast cell tumors are not considered a differential diagnosis for a palpable anal sac mass. We describe the presentation, management, and prognosis of a dog with mast cell neoplasia of the anal sac.

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Case description

An 11-year-old castrated male mixed-breed dog weighing 34 kg was seen for routine annual examination. The dog had a history of 2 cutaneous mast cell tumors (cMCTs) surgically excised ~12 mo before. These were from the left lateral thorax and left inguinal regions. Results of histopathologic evaluations of both masses were consistent with low-grade Kiupel/grade 2 Patnaik cMCTs with complete excision. The mass from the left lateral thorax was reported to have a mitotic count (MC) of 0, and the

inguinal mass was reported to have an MC of 1 in representative fields of 2.37 mm^2. Physical examination was unremarkable aside from a well-demarcated, 2- to 3-millimeter left-sided anal sac mass. Routine complete blood (cell) count (CBC), serum chemistry profile, total T4, and urinalysis results were unremarkable. The dog was sedated with butorphanol, 0.15 mg/kg body weight (BW), IV and dexmedetomidine hydrochloride 7.3 μg/kg BW, IV. Fine-needle aspiration of the left anal sac mass was conducted and cytopathologic evaluation reported small numbers of well-differentiated, fully granulated mast cells, small numbers of eosinophils, and rare fibroblasts. Three-view thoracic radiographs showed no evidence of pulmonary or cardiac abnormalities. A complete abdominal ultrasound revealed no abnormalities, including a detailed evaluation of the liver, spleen, and iliosacral lymph nodes. Ultrasound-guided fine-needle aspiration of the spleen was completed. Cytopathologic examination revealed normal splenic tissue with no evidence of metastatic mast cell neoplasia.

The dog was anesthetized with acepromazine maleate, 0.015 mg/kg BW, IM and hydromorphone, 0.1 mg/kg BW, IM, as premedication; and midazolam, 0.25 mg/kg BW, IV with ketamine hydrochloride, 5 mg/kg BW, IV, as induction. After induction and endotracheal intubation, anesthesia was maintained with sevoflurane (2 to 4%) and oxygen. A purse-string suture was placed to close the anal orifice and the perineum was surgically prepared in routine manner. Perioperative antimicrobial therapy with cefazolin, 22 mg/kg BW, IV was administered. A standard closed anal sacculectomy was done without complication. The dog recovered uneventfully. Carprofen, 2.14 mg/kg BW, PO, q12h and codeine, 0.9 mg/kg BW, PO, q8h were prescribed for postoperative pain management.

Histopathologic examination confirmed the cytologic diagnosis of a mast cell tumor. The excised tissue revealed small aggregates of neoplastic mast cells spanning nearly 2 to 3 mm in diameter in the region of the submucosa (Figure 1 A). Neoplastic cells were round, with discrete cell borders. The cells displayed moderate amounts of well-granulated cytoplasm. Nuclei were ovoid, with stippled chromatin and punctate nucleoli. Anisocytosis and anisokaryosis were mild. No mitotic figures were identified in ~1.5 high-power fields, 400×. The narrowest surgical margin was composed of 290 μm of collagen. Immunohistochemistry was done for CD117 (c-kit) and Ki-67. The neoplastic cells demonstrated a strong membranous immunohistochemical pattern of expression of CD117 (KIT pattern 1) (Figure 1 B) and were diffusely negative for immunoreactivity to Ki-67 (Figure 1 C). The results of polymerase chain reaction (PCR) amplification to detect internal tandem duplication (ITD) mutations of exon 8 and exon 11 in the *c-kit* gene were negative.

Physical examinations and repeat abdominal ultrasounds were done 4 mo and 8 mo after surgery. The dog was doing well with no owner concerns at each of these visits. Results of complete physical examinations, including digital rectal examinations, were unremarkable. No palpable abnormalities affecting the previous surgery site or contralateral anal sac were detected. At the 8-month postoperative recheck, routine CBC revealed a mild monocytosis (1442 cells/μL; reference range: 0 to 840 cells/μL). The serum chemistry profile revealed a mildly elevated alanine transaminase (ALT, 174 IU/L; reference range: 12 to 118 IU/L). The total T4 and urinalysis results were unremarkable.

Approximately 12 mo following the initial consultation for the left anal sac mass, repeat physical examination including digital rectal examination was unremarkable, aside from 2 new dermal masses. Fine needle aspirates confirmed additional cMCTs in the left axilla and left lateral thorax. The mass on the left lateral thorax was ~20 cm distant from the previous mast cell tumor removed from this general location 2 years before. Thoracic radiographs obtained before anesthesia revealed no abnormalities. Repeat abdominal ultrasound was once again unremarkable, with no evidence of iliosacral lymphadenopathy. Ultrasound-guided fine-needle aspiration of the liver and spleen was completed, revealing no evidence of visceral metastatic disease. Routine CBC before surgery was unremarkable. The serum chemistry profile revealed a mildly elevated ALT (135 IU/L; reference range: 12 to 118 IU/L). Both masses were surgically removed in a routine fashion without complication. Histopathology for both masses was consistent with completely excised, low-grade Kiupel/grade 2 Patnaik cMCTs. No mitotic figures were observed in either mass in representative fields of 2.37 mm^2.

Discussion

Neoplasms of the perineum, including cMCTs, are common in dogs. However, this report describes a mast cell tumor arising from the anal sac, which, to the authors' knowledge, has not been previously described in the veterinary literature; its prognosis is thus unknown. The anal sacs are paired invaginations of the skin located between the internal and external sphincters of the anus, lined by keratinizing stratified squamous epithelium (7). Sebaceous glands and apocrine glands are located subjacent to the connective tissue supporting the epithelium of the anal sac (8). The sebaceous glands are limited to the duct of the anal sac, whereas apocrine glands are concentrated in the fundus (8). Tumors arising from the anal sacs demonstrate both a distinct biological behavior and differ histologically when compared to the more common perianal gland tumors (9). Primary neoplasia of the canine anal sac is relatively uncommon, accounting for 17% of perianal tumors and 2% of all cutaneous tumors (2). Apocrine gland anal sac adenocarcinoma (AGASACA) is the most common neoplasm of the canine anal sac. Other canine primary anal sac tumors, which are infrequently encountered, include squamous cell carcinoma, malignant melanoma, and a single reported case each of a benign papillary cystadenoma and a collision tumor consisting of an AGASACA and a soft tissue sarcoma (10–13). Diagnosis of anal sac neoplasia involves a thorough rectal examination in conjunction with cytologic assessment or histopathologic confirmation. Apocrine gland anal sac adenocarcinoma is considered an aggressive malignancy that commonly metastasizes to regional lymph nodes, liver, spleen, and bone (1,9,14). Removal of the anal sac tumor and metastatic lymph nodes, if present, is the standard of therapy and should be pursued if feasible (14). Additional therapy, if indicated, may include radiation, electrochemotherapy, or chemotherapy, although the role of the latter in extending survival times is currently unclear (1,9,14).

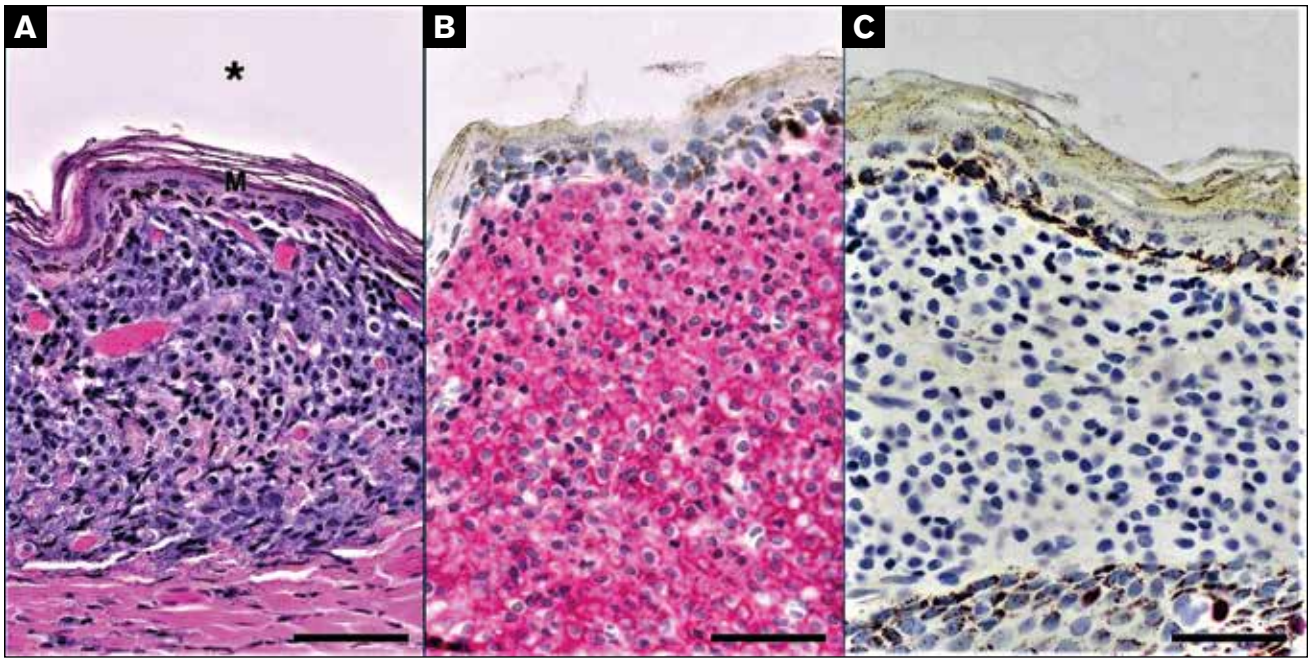

Figure 1. Histopathology. A – Mast cell tumor in an 11-year-old male dog. Hematoxylin and eosin staining. Anisocytosis and anisokaryosis were mild. The asterisk indicates the lumen of the anal sac. "M" indicates the mucosa of the anal sac. The tumor is below, located in the submucosa, immediately subjacent to the epithelium. B – Immunohistochemistry for CD117 (KIT pattern I), with membranous staining. C – Immunohistochemistry for Ki-67; Ki-67 immunolabeling was diffusely negative. Scale bar = 50 μm in A–C.

Cutaneous mast cell tumors have been well-described and extensively documented in the veterinary literature. Mast cell tumors are the most reported cutaneous neoplasm in the dog, representing 16 to 21% of all cutaneous tumors (2). Most cMCTs are located on the trunk and perineal region (50%), limbs (40%), and head and neck regions (10%) (2). Less commonly, mast cell neoplasia can occur at subcutaneous, mucosal, extracutaneous/extramucosal sites, and rarely as systemic mast cell leukemia (15). The biologic activity of cMCTs is strongly correlated with histopathological grading (2,16–19). Surgery remains the cornerstone of therapy for amenable tumors. Additional therapies may include radiation therapy, systemic chemotherapy or tyrosine kinase inhibitor therapy, electrochemotherapy, palliative therapy, and recently, tigilanol tiglate injection (Stelfonta; QBiotics Group, Taringa, Queensland, Australia) (1,2,19–24). Differences in the biologic behavior of canine cMCTs based on anatomic location have been documented. Of particular interest are dogs with cMCTs of the inguinal or perineal regions, including scrotal and preputial locations. Debate exists as to whether these animals have a worse prognosis. Multiple studies have failed to document a survival difference based on location (16,25). Two papers specifically looking at prognosis in dogs with inguinal and perineal cMCTs showed that, with aggressive therapy, many of these animals benefited with prolonged survival times (3,4). However, dogs with cMCTs of the scrotum and preputial regions had a shorter disease-free interval when compared to those with cMCTs at locations other than the perineum and inguinal region, and were more likely to receive systemic therapy (4). In addition, cMCTs located on the muzzle, head/neck, and paw may also carry a worse prognosis (5,6).

Histologic grading of canine cMCTs is most predictive of outcome and prognosis, and is instrumental in case management (6,16,18,26,27). Histologic grading applies only to cMCTs, and not to subcutaneous, mucosal, or extracutaneous/extramucosal mast cell tumors. Currently, the Kiupel and Patnaik grading systems are most widely used for the classification of cMCTs. The Patnaik grading system assigns a grade of 1, 2, or 3 based on well-, intermediate-, or poorly-differentiated tumors, respectively (28,29). Tumor grade is significantly related to survival time, with 93% of grade 1, 44% of grade 2, and 6% of grade 3 patients surviving to 1500 d (28). The Kiupel grading system is a 2-tiered system that divides cMCTs into either high-grade or low-grade tumors based on several criteria, including the number of mitotic figures, multinucleation of cells, presence of bizarre nuclei, and karyomegaly (30). Using this grading system, the median survival of dogs with high-grade tumors was 3.65 mo, compared to 23 mo for those assigned as low-grade (30). Currently, the Oncology-Pathology Working Group (OPWG), which is a joint initiative of the Veterinary Cancer Society and the American College of Veterinary Pathologists, recommends that both the Patnaik and Kiupel grading systems be included with canine cMCT histopathology reports (29).

Mitotic index (MI) is a quantitative evaluation, of number of cells undergoing mitosis divided by the number of cells not in mitosis, that provides an indirect assessment of cellular proliferation. The MI has been shown to significantly correlate with metastatic rate and median survival time (MST), but not with tumor recurrence (31). Romansik *et al* (31) demonstrated that the MST for dogs with non-metastatic cMCT with an MI $\leq$ 5 was 80 mo, compared to 3 mo for those patients with non-metastatic cMCT with an MI $>$ 5. A validation study

investigating these cut-points showed an MST of 8 mo for dogs with an MI $>$ 5, whereas the MST was not reached for dogs with an MI $\leq$ 5 (32). The mitotic count (MC), the number of mitotic figures within a given area, is the term preferred over MI by OPWG, to better standardize the number of mitotic figures reported (29).

A subset of low-grade cMCTs with an MC $\leq$ 5 may still behave in an aggressive clinical fashion (29). Given this variability in the biologic activity, numerous prognostic markers have been investigated to further assess the potential for local regrowth, the development of distant metastasis, and mast cell tumor-associated morbidity and mortality. It is important to remember that no single marker should be used as a prognostic factor; rather, markers should be used in concert with the histopathologic grade, MC, clinical presentation, and clinician experience. Immunostaining for Ki-67, a marker of cellular proliferation, has been evaluated in numerous studies to better determine the biologic behavior of mast cell tumors. Increased Ki-67 counts have been associated with tumor regrowth, the development of metastasis, and overall increased tumor-related mortality (16,26). The KIT protein (CD117) pattern localization evaluated by immunohistochemistry has shown differing patterns correlating with tumor aggressiveness. The CD117 protein is a Type-III tyrosine kinase protein involved in mast cell growth and differentiation (18). Membrane-associated (pattern 1) KIT pattern staining of neoplastic cells is not associated with recurrence or a decrease in survival time. Conversely, staining patterns 2 (focal to stippled cytoplasmic staining with decreased membrane-associated staining) and 3 (diffuse cytoplasmic staining) are both significantly associated with a shorter overall survival time and a higher rate of local recurrence (33). Evaluation for the presence of internal tandem duplications (ITD) in exons 11 and 8 of the *c-kit* oncogene by PCR has been evaluated in multiple studies. Internal tandem duplication mutations of exon 11 in *c-kit* in cMCTs have been associated with a higher risk of mast cell metastasis, a shorter disease-free interval, increased mortality due to mast cell tumor-related death, and increased tumor recurrence when compared to tumors lacking ITD mutations in *c-kit* (16,17,27). The presence of ITD mutations of exon 8 in *c-kit* may indicate a less aggressive biologic activity in cMCTs (31). Like tumors without ITD mutations, cMCTs with mutations of exon 8 do not have a significant increase in proliferation markers (34). Conversely, tumors with ITD mutations of exon 11 are associated with an increased MC, aberrant protein localization of KIT, increased Ki-67 labeling index, and higher grade in both the Kiupel and Patnaik grading systems (16,27).

The reported prevalence of multiple cMCTs at the time of initial evaluation varies widely, ranging from 9 to 44% of patients (21,35). The presence of multiple cMCTs and their effect on prognosis has been evaluated in various studies with conflicting results. It has been stated that dogs with multiple synchronous cMCTs at the time of diagnosis that are treated with surgery alone have a worse overall prognosis (25). However, in several other studies, the MST of dogs with multiple cMCTs was not reached (19,21,35). Additionally, 18 to 44% of dogs with multiple cMCTs that received surgery alone or surgery with adjuvant therapy (chemotherapy and/or radiation therapy) developed additional cMCTs at sites distant from the original surgery site, with no effect on overall survival (19,35).

This report describes a mast cell tumor arising from the anal sac, which has not been previously described in the veterinary literature; its prognosis is thus unknown. Twelve months following the surgical removal of the mass *via* anal sacculectomy, no local recurrence or evidence of metastatic disease was evident. The anal sac mast cell tumor in this report had a membranous CD117 staining pattern, stained diffusely negative for Ki-67, had an MC of 0, and was negative for *c-kit* mutations, suggesting a more favorable biologic behavior. Had this mass been in a more conventional cutaneous location, it would have been graded as low-grade Kiupel/grade 2 Patnaik cMCT. The anal sac mast cell tumor in this case appeared to behave biologically like low-grade cMCTs arising from more traditional cutaneous locations. In dogs with a history of a cMCT and a palpable anal sac mass, cytological evaluation is important to confirm the diagnosis and guide staging and therapeutic options.

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Article

Professional characteristics, attitudes, and practices associated with stress and quality of life among Canadian animal health workers

José Denis-Robichaud, Nikky Millar, Valérie Hongoh, Hélène Carabin, Lucie Richard, Cécile Aenishaenslin

Abstract

Objective

To describe the knowledge, attitudes, and practices (KAP) towards COVID-19 of Canadian companion animal health workers (AHW); to measure their perceived stress and quality of life (QoL); and to explore professional risk factors associated with stress and QoL.

Sample

We sampled 436 companion animal veterinarians and technicians.

Procedure

The study had cross-sectional and cohort components. It was conducted online in August to December 2020, and repeated in May to July 2021, using a questionnaire assessing the respondents' professional characteristics, COVID-19 KAP, perceived stress, and QoL.

Results

Overall, AHW had sufficient knowledge of COVID-19 transmission, and reported having adopted good preventive practices. Since the beginning of the pandemic, participants reported increases in new clients (76%), in refusal of new clients (53%), and in pet euthanasia (24%). Increased client refusal and pet euthanasia were associated with greater stress and poorer professional QoL, whereas perceived susceptibility to and adoption of measures against COVID-19 were associated with lower stress and better QoL.

Conclusion and clinical relevance

For AHW, professional characteristics were associated with stress and professional QoL. This information is important for developing strategies to cope with the ongoing shortage of AHW and with future public health crises.

Résumé

Caractéristiques professionnelles, attitudes et pratiques associées au stress et à la qualité de vie des travailleurs en santé animale au Canada

Objectif

Décrire les connaissances, attitudes et pratiques (KAP) envers la COVID-19 des travailleurs canadiens en santé des animaux de compagnie (AHW); mesurer leur stress perçu et leur qualité de vie (QoL); et explorer les facteurs de risque professionnels associés au stress et à la QoL.

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Unpublished supplementary material (Appendices I, II, III) is available online from: www.canadianveterinarians.net

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Échantillonnage
Nous avons échantillonné 436 médecins vétérinaires et techniciens en pratique des animaux de compagnie.

Procédure
L'étude avait des composantes transversale et de cohorte. Elle a été menée en ligne d'août à décembre 2020, et répétée de mai à juillet 2021, à l'aide d'un questionnaire évaluant les caractéristiques professionnelles des répondants, leurs KAP envers la COVID-19, leur stress perçu et leur QoL.

Résultats
Dans l'ensemble, les AHW avaient une connaissance suffisante de la transmission de la COVID-19 et ont déclaré avoir adopté de bonnes pratiques de prévention. Depuis le début de la pandémie, les participants ont signalé une augmentation du nombre de nouveaux clients (76 %), du refus de nouveaux clients (53 %) et de l'euthanasie des animaux de compagnie (24 %). L'augmentation du refus des clients et de l'euthanasie des animaux de compagnie était associée à un plus grand stress et à une QoL professionnelle plus faible, tandis que la perception du risque et l'adoption de mesures contre le COVID-19 étaient associées à un stress plus faible et à une meilleure QoL.

Conclusion et pertinence clinique
Pour les AHW, les caractéristiques professionnelles étaient associées au stress et à la QoL. Ces informations sont importantes pour développer des stratégies pour faire face à la pénurie continue d'AHW et aux futures crises de santé publique.

(Traduit par Dr Serge Messier)

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Introduction

Following the COVID-19 pandemic declaration by the World Health Organization in March 2020, the government of Canada declared a state of public health emergency. This was soon followed by recommendations for the general population to shelter at home and to limit travel outside of their homes except for essential work and acquiring basic necessities. Veterinary clinics were listed among essential services and recommendations were made by veterinary regulator entities (*e.g.,* Ordre des Médecins vétérinaires du Québec) to treat only emergency cases and postpone all nonessential appointments and surgeries (1). Although this recommendation may seem relatively straightforward, exactly what constituted an "emergency" was left to the judgment of veterinarians (2). Furthermore, conditions not initially considered an emergency may become urgent when postponed. Implementation of infection control measures was also recommended at all veterinary clinics to help prevent the spread of COVID-19 (1).

In knowledge, attitude, and practice (KAP) studies conducted in China, Vietnam, and Italy, although > 80% of human health workers had a sufficient level of knowledge about the SARS-CoV-2 virus, they also expressed high levels of concern regarding the disease (3–6). Despite this, that health workers in Chinese health centers still expressed willingness to care for patients infected with COVID-19 was attributed to training and previous experience caring for such patients (4). In another study in China, frontline health workers practiced strict preventive behaviors, which were associated with higher levels of education and < 8 h of work per day (3). In a study from Vietnam, high knowledge levels among human health workers were associated with positive attitudes, including willingness to self-isolate if infected with COVID-19 (5).

Evidence of SARS-CoV-2 transmission to companion animals was limited at the beginning of the pandemic (7), but was suspected, especially for cats and ferrets (8). To our knowledge, only 1 study, conducted in Nigeria, assessed SARS-CoV-2-related KAP of animal health workers (AHW) (9). In that study, 67% of participants had satisfactory knowledge scores for COVID-19, and 98% reported practicing mitigation measures while working. Investigations into workplace practices before the current pandemic revealed that use of personal protective equipment (PPE) by veterinarians was generally poor (10).

Before the pandemic, a cross-sectional Canadian study of veterinarians reported higher mean scores than the general population for burnout, anxiety, and depression, with female veterinarians having significantly higher scores than their male counterparts (11). This study used multiple validated tools to assess mental health and quality of life (QoL) of participants, including the perceived stress scale (PSS) and the ProQoL, which is used to assess professional QoL. This recent study mainly assessed gender differences for mental health and QoL indicators, but in previous research, work-related factors such as workload and euthanasia were associated with compassion fatigue, burnout, and suicide (12,13). These work-related factors seemed to change during the pandemic, but also before and likely after (14), contributing to poor mental health and QoL of veterinarians.

Although the COVID-19 pandemic generated stress and decreased QoL in the general population (15), it is unclear how AHW were affected. We hypothesized that strict population-level containment strategies and uncertainties around risks of exposure to SARS-CoV-2 *via* infected companion animals generated severe stress and decreased QoL among AHW.

Our objectives were to describe the KAP for COVID-19 of Canadian companion animal veterinarians and animal health

Table 1. Information related to indices describing diverse characteristics of animal health workers in Canada, including tested and included questions, and Cronbach's alpha for each index.

Index	Cronbach's alpha	Questions	Included
Perceived susceptibility	0.77	If other Canadians do not follow protective measures against COVID-19, MY risk of becoming infected is [very low to very high]	Yes
		If other Canadians do not adopt protective measures against COVID-19, their risk of becoming infected is [very low to very high]	Yes
Worrying	0.56	COVID-19 is a severe disease [strongly disagree to strongly agree]	Yes
		It is easy to protect myself against COVID-19 [strongly disagree to strongly agree]	No
		I believe there is great scientific uncertainty around COVID-19 [strongly disagree to strongly agree]	No
		I am worried about becoming infected with COVID-19 [strongly disagree to strongly agree]	Yes
Perception of measures' efficiency	0.85	Wearing a mask while at work [strongly disagree to strongly agree]	Yes
		Limit the number of clients in the clinic [strongly disagree to strongly agree]	Yes
		Use of personal protective equipment during consultations [strongly disagree to strongly agree]	Yes
		Regular disinfection of surfaces [strongly disagree to strongly agree]	Yes
		Installation and use of a plexiglass barrier [strongly disagree to strongly agree]	Yes
		Have clients leave their pets at the entrance [strongly disagree to strongly agree]	Yes
		Conduct triage by phone before scheduling appointments with clients [strongly disagree to strongly agree]	Yes
		Advise workers to stay home if they have any symptoms compatible with COVID-19 [strongly disagree to strongly agree]	No
Adopted measures	0.58	Wearing a mask while at work [never to always]	No
		Limit the number of clients in the clinic [never to always]	Yes
		Use of personal protective equipment during consultations [never to always]	Yes
		Regular disinfection of surfaces [never to always]	Yes
		Installation and use of a plexiglass barrier [never to always]	No
		Have clients leave their pets at the entrance [never to always]	No
		Conduct triage by phone before scheduling appointments with clients [never to always]	No
		Advise workers to stay home if they have any symptoms compatible with COVID-19 [never to always]	No

technicians; to measure their perceived stress and QoL; to describe changes in KAP, stress, and QoL between 2 periods of the pandemic; and to explore professional risk factors associated with stress and QoL during the early stages of the COVID-19 pandemic.

Materials and methods

Study design

This study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of the Université de Montréal (CERSES-20-097-D; approved on July 22, 2020). We first designed this study as a cohort study, whereby participants of a first online survey were to be followed in time to measure changes in stress, QoL, and KAP about COVID-19 during the pandemic. The questionnaire was first shared from August to December 2020 (T1), and participants who gave their consent for a follow-up questionnaire were contacted again from May to July 2021 (T2). We explored associations between work-related and KAP factors and stress and QoL outcomes, with a cross-sectional design, during the period for which veterinary clinics had the greatest stringency (T1).

Source population and recruitment strategy

The target-source population was a convenience sample. We contacted the Canadian Veterinary Medical Association (CVMA) and the provincial veterinary and animal health technician associations by email and asked them to share an invitation to participate in the study with their members (open voluntary survey). These associations shared the invitation to their members through newsletters and listserv communication. Participants were included if they were veterinarians or animal health technicians, 18 y or older, residents of Canada, and currently practicing in companion animal health clinics in Canada (including general, emergency, referral, and mixed practice).

Measurement of variables of interest

The LimeSurvey platform (https://www.limesurvey.org/) was used to administer an online electronic questionnaire. We

developed the questionnaire in English (see Appendix I, available online from: www.canadianveterinarians.net) and translated it into French. During the development phase, the questionnaire was tested by 8 collaborators, and 37 questions were modified following this testing phase to improve clarity. The final questionnaire was presented on 13 pages with 1 to 3 questions per page, or a table with multiple statements. Participants were allowed to go back through the questionnaire and change their answers before submitting it.

Information about the survey was provided to participants when they accessed the survey online, at which point they were asked for their informed consent (whether they agreed to the conditions of the survey) (Appendix I, available online from: www.canadianveterinarians.net). Participants were asked to answer sociodemographic and work-related questions, including about their gender, age, and province; occupation (veterinarian or animal health technician); years of experience; and work schedule.

Questions about knowledge, risk perception, adoption of preventive measures at work, and perception of the effectiveness of such measures were developed following the Health Belief Model (16). These questions were asked only in the first questionnaire (T1). Sufficient knowledge about modes of transmission of COVID-19 was defined as correctly classifying 7 of 8 choices (modes of transmission: droplets, aerosols, surfaces, food, humans, and humans to animals; not modes of transmission: mosquitoes and water), following information available from the public health expertise and reference center at the time of the survey (17).

We summarized various KAP elements in indices averaging multiple questionnaire elements selected using a factor analysis (Table 1). Briefly, this factor analysis was done using a principal factor method and an oblique rotation transformation. Variables with an item-total correlation > 0.5 were included (18), and the internal consistency reliability of each index was assessed using Cronbach's alpha (19).

Perceived susceptibility to COVID-19 was assessed with 2 Likert scale questions (5 points, very low to very high) and worrying about COVID-19 was assessed with 2 Likert scale questions (5 points, strongly disagree to strongly agree). Perception of the efficiency of various measures to prevent the spread of COVID-19 was assessed with 7 Likert scale questions (5 points, strongly disagree to strongly agree), whereas adoption of measures to prevent the spread of COVID-19 was assessed with 3 Likert scale questions (4 points, never to always). Participants were also asked to answer "yes" or "no" to questions asking whether they perceived that there had been increases in euthanasia, treatment refusals from their clients, new clients, and refusal of new clients since the beginning of the pandemic.

We used standardized questions to assess perceived stress. The PSS is a validated, 10-item, self-reported instrument that scores participants' responses regarding the frequency of positive and negative feelings over the previous month (20). This tool estimates a stress level, with 40 being the highest level of perceived stress, and 0 the lowest. Participants' QoL was assessed for their personal and professional lives. The EQ-5D is a validated, 5-item instrument that has been used to assess personal QoL in research and clinical trials (21). The ProQoL is a 30-item instrument used to assess professional QoL of those working in caregiving domains (22). The EQ-5D tool includes 5 questions regarding mobility, self-care, usual activities, pain and discomfort, and anxiety and depression, as well as 1 question on overall health. The combined results across the 5 questions were translated on a standardized scale validated for Canadians (utility score) (23). The ProQoL tool gives 3 scores, ranging from 10 to 50, for compassion satisfaction, burnout, and secondary traumatic stress. The 3 scores can be categorized as low, middle, or high, following a normative benchmark (24).

Statistical analyses

We conducted statistical analyses using R software (version 4.0.5) with the R Studio interface (Version 1.3.1093) (25). Multiple entries from the same IP address and incomplete questionnaires were manually removed. The loss-to-follow-up bias was assessed by comparing participants who completed both questionnaires to participants who did not for sociodemographic variables, KAP, and stress and QoL variables at T1. Proportions and 95% confidence intervals (CI) were calculated for categorical variables, and medians and ranges were obtained for continuous variables. The change in KAP, stress, and QoL between T1 and T2 was assessed graphically, when available (knowledge about COVID-19, increase in new clients, new client refusal, treatment refusal, euthanasia, PSS, QoL, and ProQoL). In addition, agreement between T1 and T2 was assessed using the Cohen kappa statistics for dichotomized variables (increase in new clients, new client refusal, treatment refusal, and euthanasia).

Complete-case models to explore the association between work-related variables and stress and QoL were built using data from the first survey (T1) with a regressive elimination approach, following the causal diagram developed by the research team (available at dagitty.net/mhNYbCj) and keeping confounders with $P < 0.16$ (26). The PSS and QoL utility scores were assessed with linear regression models. The ProQoL scores were coded as binary outcomes and assessed with logistic regression models. Categorical variables selected by $< 1\%$ of respondents were considered as missing values in the models. Linearity and homoscedasticity of the residuals were verified for the linear models, and the fit of the logistic regression models was assessed using the Hosmer and Lemeshow goodness-of-fit test.

Results

Totals of 607 and 340 respondents started the first (T1) and second (T2) questionnaires, and totals of 519 and 302 completed them, respectively, representing completion proportions of 85.5 and 88.8%. After considering inclusion criteria, 436 and 189 participants were eligible at T1 and T2, respectively, representing a loss to follow-up of 56.5%. Participants who completed both surveys were generally similar to participants who did not, but were older and had more work experience (Table 2). Almost all participants were women, with a majority aged between 25 and 44 y, and ~2/3 were animal

Table 2. Descriptive statistics for sociodemographic; work-related; and knowledge, attitude, practice variables for animal health workers in Canada from August to December 2020 (T1) who completed only the first survey (T1) or both surveys [T1 and T2 (May to July 2021)] as part of a cohort study on stress and quality of life of animal health workers during the early stage of the COVID-19 pandemic. Categorical variables are presented as the proportion per category with 95% confidence intervals (CI), or as the proportion with 95% CI for the "yes" category for "yes/no" variables. Continuous variables are presented as the mean with 95% CI.

Variables	Missing values	Proportion or mean (95% CI) Completed T1 only (n = 247)	Completed T1 and T2 (n = 189)
Gender	0		
Woman		94.0% (90.0; 96.5)	94.2% (89.6; 96.9)
Man		5.2% (2.9; 9.0)	4.2% (2.0; 8.5)
Other		0	0.5% (0; 3.4)
Prefer not to answer		0.8% (0.1; 3.2)	1.1% (0.2; 4.2)
Age (y)	0		
18 to 24		10.1% (6.8; 14.7)	6.9% (3.9; 11.7)
25 to 34		46.0% (39.7; 52.4)	38.6% (31.7; 46.0)
35 to 44		27.0% (21.7; 33.1)	26.5% (20.4; 33.4)
45 to 54		10.5% (7.1; 15.1)	18.0% (12.9; 24.4)
55+		6.5% (3.9; 10.5)	10.1% (6.3; 15.5)
Region	0		
Western provinces and Territories[a]		21.8% (16.9; 27.5)	23.8% (18.1; 30.6)
Ontario		25.4% (20.2; 31.4)	30.7% (24.3; 37.9)
Quebec		36.3% (30.4; 42.6)	30.7% (24.3; 37.9)
Atlantic provinces[b]		16.5% (12.3; 21.9)	14.8% (10.2; 20.9)
Occupation	0		
Veterinarian		35.1% (29.2; 41.4)	32.8% (26.3; 40.1)
Animal health technician		64.9% (58.6; 70.8)	67.2% (59.9; 73.7)
Experience (y)	0		
< 5		35.5% (29.6; 41.8)	23.8% (18.1; 30.6)
5 to 10		21.0% (16.2; 26.7)	24.9% (19.0; 31.8)
11 to 15		17.7% (13.3; 23.2)	15.3% (10.7; 21.5)
16 to 20		13.7% (9.8; 18.8)	11.1% (7.2; 16.7)
≥ 21		12.1% (8.4; 17.0)	24.9% (19.0; 31.8)
Working schedule	36		
Did not work		4.8% (2.6; 8.7)	3.5% (1.4; 7.7)
Worked part-time		15.4% (11.1; 20.8)	17.3% (12.2; 24.0)
Worked < 40 h/wk		21.9% (16.9; 28.0)	23.1% (17.2; 30.3)
Worked 40 to 50 h/wk		48.3% (41.6; 54.9)	48.0% (40.4; 55.7)
Worked > 50 h/wk		9.6% (6.3; 14.4)	8.1% (4.7; 13.5)
Sufficient knowledge about COVID-19	18	53.4% (46.8; 59.9)	65.8% (58.4; 72.5)
Perceived susceptibility index	18	4.3 (4.0; 4.3)	4.3 (4.2; 4.5)
Worrying about COVID-19 index	18	3.7 (3.7; 3.8)	4.0 (3.8; 4.0)
Perception of measures' efficiency index	18	4.4 (4.4; 4.5)	4.4 (4.4; 4.5)
Adopted measures index	98	3.7 (3.5; 3.7)	3.7 (3.5; 3.8)
Increase in new clients	18	76.9% (70.9; 82.1)	75.5% (68.6; 81.4)
Increase in new client refusal	18	52.1% (45.5; 58.7)	53.3% (45.8; 60.6)
Increase in treatment refusal	18	28.2% (22.6; 34.5)	23.9% (18.1; 30.9)
Increase of euthanasia	18	23.1% (17.9; 29.1)	24.5% (18.6; 31.4)

[a] British Columbia, Alberta, Saskatchewan, Manitoba, Yukon, and Northwest Territories.
[b] New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador.

health technicians (Table 2). A total of 20.4% of participants were veterinary clinic owners.

Reported knowledge, attitudes, and practices (KAP)

Just over 1/2 of the participants had sufficient knowledge about COVID-19 modes of transmission at T1 (58.9%, 95% CI: 54.0 to 63.6). At T2, this proportion did not increase (63.3%, 95% CI: 55.9 to 70.1), but some participants had improved knowledge (of participants who had insufficient knowledge at T1, 45.2% had sufficient knowledge at T2) or deteriorated knowledge (of participants who had sufficient knowledge at T1, 26.7% had insufficient knowledge at T2; Figure 1). Insufficient knowledge was largely driven by respondents who did not know that SARS-CoV-2 can be transmitted from humans to companion animals, which was selected by 42% and 52% of the participants at T1 and T2, respectively (see Appendix II, available online from: www.canadianveterinarians.net). In both surveys, < 1/5 of participants thought that contact with an infected animal was a mode of transmission (T1: 19.1%, 95% CI: 15.5 to 23.3; T2: 20.0%, 95% CI: 14.7 to 26.5).

Participants' index for perceived susceptibility to COVID-19 at T1 varied from low to very high (median: 4, *i.e.,* high), whereas the range of the index for worrying about COVID-19

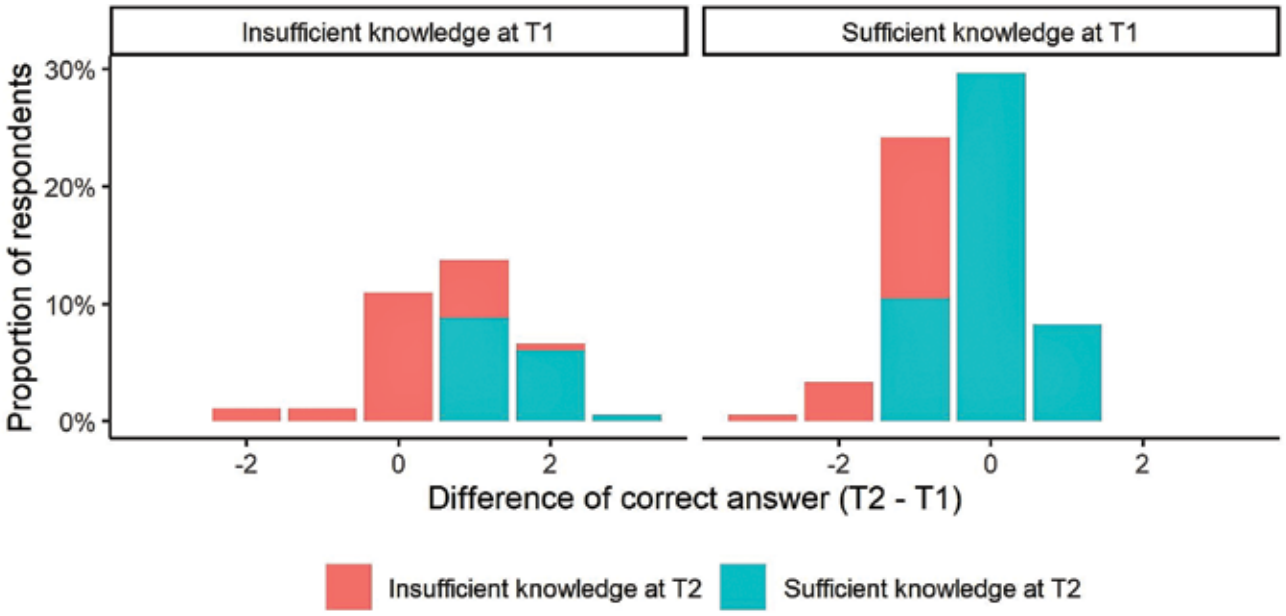

Figure 1. Distribution of the change in number of correct answers to identifying COVID-19 modes of transmission at 2 times during the COVID-19 pandemic (T1: August to December 2020, T2: May to July 2021) for animal health workers classified as having sufficient knowledge[a] at T1 and/or at T2.

[a] "Sufficient knowledge" was defined as correctly classifying 7 of 8 modes of transmission.

varied from strong disagreement to strong agreement (median: 4, *i.e.,* agreement). The index for the perception of effectiveness of the different measures varied from strong disagreement to strong agreement of effectiveness (median: 4.4, *i.e.,* agreement to strong agreement), and the index for reported adoption of various measures varied from never to always (median: 3.7, *i.e.,* sometimes to always). Based on detailed frequency of adoption of the 8 measures, almost all measures were generally reported to be adopted by the participants (Appendix II, available online from: www.canadianveterinarians.net). However, conducting triage by phone was always done by 45.1% of respondents, regular disinfection was always done by 60.3% of respondents, and plexiglass was never used by 18.3% of respondents (but was always used by 65.3%).

At T1, 76.3% of the participants perceived that there was an increase in new clients since the beginning of the pandemic, and 52.6% refused new clients. In addition, 23.7% of participants perceived there was an increase in the number of euthanasia procedures they had to perform, and 26.3% perceived there was an increase in treatment refusal from their clients. Proportions of respondents who perceived increases in new clients, refusal of new clients, euthanasia, and treatment refusal were similar at T2, but there was poor agreement between perception of T1 and T2 (Appendix II, available online from: www.canadianveterinarians.net).

Stress and quality of life (QoL)

Differences in PSS and QoL scores between T1 and T2 for each participant were distributed around 0 (no difference; Appendix II, available online from: www.canadianveterinarians.net). Due to the important loss to follow-up and limited differences in outcomes between T1 and T2, only data from T1 were analyzed in the following steps. The median PSS score was 22 (range: 3 to 36) and the median QoL utility score was 0.83 (range: 0.17 to 0.95). At T1, 30.9% (95% CI: 26.6 to 35.5) of participants had a low compassion satisfaction score, 65.2% (95% CI: 60.5 to 69.6) had a high burnout score, and 83.1% (95% CI: 79.1 to 86.4) had a high secondary traumatic stress score.

For every 1-point increase in adoption of measures to limit the spread of COVID-19 index, the perceived stress of the participants decreased by 2.8 points on the PSS (Table 3). Participants who perceived there was an increase in client refusal and in euthanasia since the beginning of the pandemic had slightly greater PSS than participants who did not perceive these changes (1.6 and 1.4 points, respectively; Table 3). Participants who reported not working at the time of the survey had 4.8 and 8.2 × higher odds of low compassion satisfaction and high burnout scores, respectively, than participants who worked 40 to 50 h/wk (Table 4). Participants who reported working part-time also had 2.6 × greater odds of low compassion satisfaction than participants who worked 40 to 50 h/wk. In addition, for every 1-point increase in perceived susceptibility, perceived effectiveness of measures, and adoption of preventive measures indices, odds of having a high burnout score were 0.9, 0.5, and 0.3 × lower, respectively (Table 4). Participants who thought there was an increase in euthanasia in their practice had 1.9 × greater odds of having a high burnout score (Table 4). Finally, participants who reported an increase in clients in their practice had 2.4 × greater odds of having a high secondary traumatic stress score (Table 4). No professional risk factors were associated with a difference in QoL as measured by the EQ-5D

Table 3. Estimates and 95% confidence intervals (CI) from linear regression models for variables associated[a] with perceived stress of animal health workers in Canada during the COVID-19 pandemic (August to December 2020).

Variables	Crude estimate (95% CI)	Adjusted estimate (95% CI)	Confounders included in models
Adoption of measures against COVID-19 index	−3.35 (−4.74; −1.96)	−2.81 (−4.18; −1.44)	Age
Increased new client refusal	1.90 (0.69; 3.12)	1.56 (0.36; 2.76)	Occupation and increase in new clients
Increased euthanasia	2.27 (0.84; 3.69)	1.44 (0.04; 2.83)	Age, occupation, and increase in new clients

[a] Only adjusted associations with $P < 0.05$ are presented (all models are available in Appendix III, available online from: www.canadianveterinarians.net).

(all models are presented in Appendix III, available online from: www.canadianveterinarians.net).

Discussion

Our results described the KAP of Canadian AHW related to the COVID-19 pandemic, assessed their perceived stress and QoL, and identified meaningful associations among these characteristics. In summary, positive perception and adoption of measures against COVID-19 were associated with less stress and better QoL indicators. Moreover, impacts of the pandemic such as perceived increase in clientele, increase in new client refusal, and increase in euthanasia were associated with more stress and poorer QoL indicators.

Overall, AHW had sufficient knowledge of COVID-19 transmission, perceived they had a high susceptibility to COVID-19, agreed preventive measures were effective, and had adopted good preventive practices. Our study population were Canadian AHW and included mainly educated female respondents in a high-income country, 3 identified factors associated with good COVID-19 KAP in previous studies (27–29).

Stress and quality of life (QoL)

In a recent study in the Canadian veterinarian population that used a similar recruitment strategy to the one in our study, Canadian veterinarians had an average PSS score of 17 before the pandemic; and 28% of them had a low compassion satisfaction score, 42% had a high burnout score, and 65% had a high secondary traumatic stress score (11). The average PSS score of 21 in the present study was higher than that in the study conducted before the pandemic (11). Similarly, there were greater proportions of AHW who had high burnout (65%) and high secondary traumatic stress (83%) scores than in the study by Perret *et al* (2020) (11). The AHW in the present study also seemed to have a lower QoL (average utility score: 0.80) than the Canadian general population during the early stage of the COVID-19 pandemic (utility score: range = −0.01 to 0.95, median = 0.87) (30).

Compared to existing literature, we inferred that AHW have lower QoL than the general population, corroborating previous studies that veterinarians have increases in anxiety, burnout, depression, and suicide compared to the general population (11,31,32). The population we studied, however, also included animal health technicians. We inferred that these burdens were likely shared by all AHW, not only veterinarians. Indeed, there were no indications that the occupation (technician or veterinarian) of respondents was a risk factor for stress and professional QoL. A recent study from the USA reported that a greater proportion of veterinary support staff experienced serious psychological distress or suffered from burnout compared to veterinarians (14). The use of different tools to assess mental health and QoL and the different sociodemographic contexts in Canada and the USA could explain differences with our results. The effects of stress and poor QoL on professional activities during the pandemic has not been assessed here, but in a study from the USA involving a variety of AHW, 15% of respondents considered mental health a barrier to work during the COVID-19 pandemic (33).

In the present study, stress and professional QoL were worse than those reported by Perret *et al* (2020) for AHW before the pandemic (11). However, as our study did not assess stress and QoL before the pandemic, it is possible that participants in our study differed from those in the Perret *et al* (2020) study (11). In this case, discrepancies between studies must be interpreted with caution and remain to be validated. Nonetheless, in support of our observations, a longitudinal study from the USA reported that the pandemic had negative effects on the well-being of veterinarians and veterinary staff (14). Poorer mental health has also been reported in healthcare workers and in the general population, with some discrepancies based on location, time period, and sociodemographic characteristics (15,34).

Knowledge, attitudes, and practices (KAP)

Preventive measures were not all adopted despite an average perception that respondents were highly susceptible to COVID-19, worried about COVID-19, and strongly agreed that preventive measures were effective against COVID-19. For example, conducting phone triage was reported to be always done by < 1/2 of participants. This survey did not allow for exploration of reasons why this relatively simple measure was less commonly implemented, but leaving the definition of "emergency" cases to veterinarians' judgement could have led veterinarians to regard phone triage as unnecessary (2). For example, castration of a young male dog may not seem to be an urgent operation, but delayed castration may cause aggression to develop in the dog and may lead to the eventual abandoning of the dog by the owner due to problematic behavior. In a study during the early stages of the pandemic, emergency cases were not managed

Table 4. Odds ratio (OR) and 95% confidence intervals (CI) from logistic regression models for variables associated[a] with 3 tools measuring the professional quality of life (ProQoL) of animal health workers in Canada during the COVID-19 pandemic (August to December 2020).

Variables	Crude OR (95% CI)	Adjusted OR (95% CI)	Confounders included in models
Low compassion satisfaction			
Work schedule			
Worked 40 to 50 h/wk	Ref.	Ref.	Age and region
Did not work	4.20 (1.53; 12.14)	4.75 (1.69; 14.04)	
Worked part-time	2.09 (1.15; 3.77)	2.58 (1.38; 4.84)	
Worked < 40 h/wk	1.33 (0.76; 2.30)	1.60 (0.89; 2.86)	
Worked > 50 h/wk	1.13 (0.49; 2.45)	1.39 (0.59; 3.09)	
Perceived susceptibility to COVID-19 index	0.57 (0.40; 0.80)	0.88 (0.82; 0.95)	Age and region
Adoption of measures against COVID-19 index	0.45 (0.28; 0.74)	0.40 (0.24; 0.68)	Work schedule and region
High burnout			
Work schedule			
Worked 40 to 50 h/wk	Ref.	Ref.	Gender, experience, and region
Did not work	8.13 (1.60; 148.3)	8.20 (1.59; 150.6)	
Worked part-time	0.93 (0.52; 1.69)	1.09 (0.59; 2.06)	
Worked < 40 h/wk	0.92 (0.55; 1.56)	1.16 (0.67; 2.04)	
Worked > 50 h.0/wk	0.63 (0.31; 1.32)	0.80 (0.37; 1.73)	
Perceived susceptibility to COVID-19 index	0.64 (0.45; 0.90)	0.89 (0.82; 0.96)	Age, worrying about COVID-19, and region
Perceived effectiveness of measures against COVID-19 index	0.58 (0.38; 0.87)	0.52 (0.32; 0.84)	Work schedule, perceived susceptibility, worrying about COVID-19, and region
Adoption of measures against COVID-19 index	0.34 (0.19; 0.58)	0.31 (0.16; 0.57)	Age, work schedule, and region
Increase of euthanasia	2.10 (1.27; 3.59)	1.93 (1.16; 3.32)	Experience
High secondary traumatic stress			
Increase in new clients	2.46 (1.42; 4.22)	2.40 (1.38; 4.12)	Gender

[a] Only adjusted associations with $P < 0.05$ are presented (all models are available in Appendix III, available online from: www.canadianveterinarians.net).
Ref. — Reference category.

uniformly by veterinary practices (35). Emergency case definition and management were not assessed in the present study, but we believe that the lack of a clear definition of what can be considered "emergency" cases can add stress to the daily work of veterinarians, even after the pandemic.

Measures such as wearing a mask, limiting the number of clients, using PPE, and regularly disinfecting surfaces were generally adopted. These 4 measures were in line with the general recommendations and requirements in most Canadian provinces during the study period, which can explain the high compliance compared to AHW-specific measures (*e.g.,* phone triage and use of plexiglass). Adoption of various practices was also described by Muzzatti and Grieve (2022), but the qualitative approach of their research did not identify a gap in adoption of various practices (36). Telehealth services increased in veterinary practices in the USA in the early phase of the pandemic, but this increase only represented 38% of respondents, with discrepancies among regions (37). In clinics offering telehealth services, teletriage was commonly reported.

We summarized COVID-19 KAP questions into indices including perceived susceptibility, worrying about COVID-19, perceived effectiveness of preventive measures, and adoption of preventive measures. Both perceived susceptibility and perceived effectiveness of measures had a satisfactory Cronbach's alpha value (> 0.7) (19), but worrying about COVID-19 and adoption of preventive measures indices had a poor alpha. These poor alpha values could have been due to the low number of questions, poor relatedness, or heterogenous constructs.

Unfortunately, the factor analysis did not yield better constructs by adding factors to the indices, and these indices (with maximum alpha) were kept to simplify complex statistical models.

Changes in the workload since the beginning of the pandemic were observed by many AHW in this study. Three quarters of AHW perceived an increase in clientele since the beginning of the pandemic, 1/2 had increases in new client refusal, and 1/4 perceived increases in euthanasia and treatment refusal. It is not clear if there were real increases, but mixed methods research, anecdotal news, and internal reports identified an increase in adoptions of companion animals and increases in client numbers and euthanasia in veterinary practices in Canada and worldwide (36–38).

Risk factors

Associations between professional characteristics, COVID-19 KAP, stress, and professional QoL in AHW were, to our knowledge, not previously assessed. Indeed, research to identify risk factors for poor mental health and QoL during the pandemic have focused on activities and sociodemographic and health characteristics (15,39). Only 1 multinational study of the general population reported a weak correlation between mental health and knowledge and attitude scores, without adjustment for potential confounders such as gender and education level (28).

Differences in PSS according to the adoption of preventive measures score and the perceived increases in client refusal and in euthanasia varied between 1.4 and 2.8 points. These differences, although statistically significant, were small, considering that the PSS scale ranges from 0 to 40 (20) and, in a Canadian study on veterinarians, there was a difference of 3 to 4 points between males and females (11). As the literature assessing the association between professional characteristics or KAP and stress is limited, it is unclear how important these differences are. However, finding associations between the same characteristics or KAP and professional QoL indicators suggests these differences might be real, assuming stress and QoL are related. Work-related changes, however amplified by the pandemic, have likely continued since the end of the public health emergency (14). Our findings reiterated the importance of addressing work-related stress and its effects for animal health professionals.

Study limitations

The cross-sectional design used to evaluate associations limited our ability to suggest causation. For example, non-working AHW had greater odds of having low compassion satisfaction and high burnout scores than AHW who were working, regardless of their work schedule. We suppose, in this case, that high burnout scores would result in increased odds of not working, but our study design cannot assess directionality. As we did not assess them in time, all associations should be considered to have temporal ambiguity and causal interpretations should be avoided.

The longitudinal design that was planned for this study unfortunately resulted in poor follow-up, not allowing us to conduct repeated measures analyses. Based on descriptive analyses at T1 and T2, we inferred that sociodemographic characteristics of the population did not change. Moreover, the general absence of change in stress and QoL indicators at T2 was unexpected. When we planned this study, the progression of the pandemic was unknown and the timing of the 2 survey periods might have driven these results. Indeed, T1 was at the beginning of the second wave of cases in Canada (August to December 2020). At that time, no vaccines were available and the public health measures in place included case detection and isolation; contact tracing and quarantine; travel restrictions; restrictive closures (gathering restrictions, nonessential business and school closures); curfews; and personal measures. Conversely, T2 included the end of the third wave of cases (May to July 2021), but at that time, vaccination was available to the adult population and public health measures were generally lifted. These major changes could have had strong effects on the attitudes and practices and the stress and QoL of AHW, but we observed a lack of change between T1 and T2. Perhaps participants who had more stress and a worse QoL did not participate in T2, which would have driven the absence of changes between T1 and T2. Information about the participants' stress and QoL before the pandemic would have been helpful for assessing how the pandemic affected them, and perhaps for confirming whether our results are comparable to those of similar studies (11), but such information was not assessed in this case.

Inclusion criteria in this study limited participants to companion AHW. Although 1 study reported minimal differences in COVID-19 KAP across job roles (33), it is not clear if findings would have been the same for AHW working in other settings (*e.g.,* large animal clinics or government). This inclusion criterion could have influenced the high proportion of respondents who identify as female. Indeed, the proportion of women in the present study was higher than that in the membership of the CVMA in 2020 (62%) (40), which could have affected our findings. It is likely that our results reflected the female population of companion animal veterinarians, and the male population would need additional research.

Our findings highlighted that changes in companion animal clinics related to the pandemic; *i.e.,* increases in clientele, new client refusal, and euthanasia, were associated with poorer stress and QoL scores in AHW. However, stress and QoL were improved in AHW who had a positive perception of and reported adopting measures against COVID-19. This information should be taken into serious consideration, as the Canadian animal care professions are facing an unprecedented shortage of AHW and the potential for future public health crises cannot be ignored.

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Article

Serum C-terminal telopeptide of Type-I collagen (CTx) concentration and myocardial hyperechogenicity in cats with hypertrophic cardiomyopathy

Erin L. Anderson, Étienne Côté, Shelley Burton, Tarek Saleh

Abstract

Objective

This study sought to determine the serum concentrations of C-terminal telopeptide of Type-I collagen (CTx), a marker of collagen degradation, in a hospital population of cats with hypertrophic cardiomyopathy (HCM). The study also evaluated the prevalence of myocardial hyperechogenicity of the left ventricle (LV) in the same cats.

Animals and procedure

Cats brought to a university veterinary cardiology service entered the study when they had an echocardiographic diagnosis of HCM; echocardiographically normal cats served as controls. Serum CTx concentrations were assessed using ELISA.

Results

There was no difference in serum CTx concentrations between cats with HCM and controls (HCM: median 0.248 ng/mL, controls: median 0.253 ng/mL; $P = 0.4$). Significantly more cats with HCM (60%) showed echocardiographic LV myocardial hyperechogenicity compared to normal controls (17%; $P = 0.0057$), but serum CTx concentrations were not different between these 2 groups.

Conclusion and clinical relevance

These results indicate that, as in human patients with HCM and in contrast to earlier feline studies, there was no evidence of enhanced collagen degradation indicated by serum CTx concentrations in cats with HCM compared to normal controls.

Résumé

Concentration sérique de télopeptide C-terminal du collagène de Type I (CTx) et hyperéchogénicité myocardique chez des chats atteints de cardiomyopathie hypertrophique

Objectif

Le premier objectif de cette étude était d'évaluer le taux sérique d'un marqueur de dégradation de collagène, soit le télopeptide C-terminal du collagène de Type-I (CTx), chez les chats atteints de cardiomyopathie hypertrophique (CMH). Le deuxième objectif était d'évaluer la prévalence de l'hyperéchogénicité du myocarde du ventricule gauche chez ces mêmes chats.

Animaux et procédures

Les chats participant à l'étude avaient été présentés pour soins à un service de cardiologie vétérinaire universitaire, et ces chats avaient un diagnostic échocardiographique soit de CMH, soit d'aucune lésion cardiaque (groupe témoin). Le taux sérique de CTx a été évalué de façon immuno-enzymatique par ELISA.

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Résultats

Les résultats n'ont démontré aucune différence entre le taux sérique de CTx chez les chats atteint de CMH et le taux sérique de CTx chez les chats sans lésion cardiaque (CMH : médiane, 0,248 ng/mL; groupe témoin : médiane, 0,253 ng/mL; $P = 0,4$). Plus de chats atteints de CMH (60 %) que de chats dans le groupe témoin (17 %) ont démontré une hyperéchogénicité du myocarde du ventricule gauche à l'échocardiographie ($P = 0,0057$), quoique les taux sériques de CTx n'étaient pas différents entre ces 2 groupes.

Conclusion et signification clinique

Ces résultats n'indiquent aucune augmentation de la dégradation de collagène chez les chats atteints de CMH, ce qui s'apparente aux résultats provenant d'études antérieures de la CMH chez l'humain mais non pas à ceux provenant d'études de la CMH féline.

(Traduit par les auteurs)

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Introduction

Hypertrophic cardiomyopathy (HCM) is a highly prevalent disease in the domestic cat population, and cats are a well-recognized animal model for HCM in humans (1,2). The disease process is initiated by genetic mutations in proteins of the cardiac sarcomere. Over 2000 pathologic mutations affecting at least 11 different cardiac proteins have been identified in humans with HCM; the most commonly affected proteins are beta-myosin heavy chain and myosin-binding protein C (3). In comparison, only 4 mutations, affecting genes that code for myosin-binding protein C [Maine coon (4), ragdoll (5)], beta-myosin heavy chain [1 domestic shorthair (6)], and ALMS1 [sphynx (7)] have been identified in HCM in cats.

Characteristic histologic changes in feline and human HCM include myocyte hypertrophy and disarray, coronary microvascular remodeling, regional myocardial ischemia, and remodeling of the extracellular matrix (ECM) (1,8–13). Within the ECM, signaling pathways stimulate excessive fibroblast secretion and deposition of collagen with subsequent interstitial fibrosis (10,11). Associations between myocardial fibrosis and sudden cardiac death, ventricular arrhythmias, and congestive heart failure are important features of HCM in human patients (10,12,13).

Myocardial fibrosis can be estimated clinically using indirect methods. Serum biomarkers of collagen turnover have been investigated in humans with disorders resulting in myocardial fibrosis. Both fibrillar collagen Types I and III are found in the cardiac ECM (14,15). They are synthesized as procollagens that undergo endoproteinase cleavage of propeptide extension domains before the mature collagen molecule cross-links and assembles into collagen fibers (14,15). The extension peptides are the amino (N)-terminal and carboxy (C)-terminal ends; these are released in a stoichiometric ratio to the active collagen molecule (16,17). Both are found in the vascular space, where they can be measured in serum (16–18). The C-terminal propeptide is stabilized by interchain disulfide bonds, which the N-terminal propeptide lacks. This makes the C-terminal of Type-I collagen (PICP) a reliable marker for collagen synthesis in various disease states (19,20). During collagen fiber disassembly, similar N- and C-terminal extension peptides, called telopeptides, are cleaved from collagen molecules by matrix metalloproteinases. The telopeptides consist of non-helical sequences of collagen and are measured in serum as surrogate markers of collagen degradation (21). Both the C-terminal end that includes the non-helical telopeptide and a terminal helical segment (ICTP or CITP), as well as the C-terminal end without the helical segment (CTx), are measurable in serum using commercially available ELISA methodology (21–23).

Serum concentrations of PICP (Type-I collagen synthesis) and ICTP (Type-I collagen degradation) (Figure 1) have been investigated in humans with heart disease, including HCM (24,25). Ho *et al* identified increased serum concentrations of PICP, increased serum PICP:ICTP, and no change in serum concentrations of ICTP in asymptomatic human patients with HCM compared to normal controls (25). The investigators concluded that the serum biomarker changes reflected a profibrotic state that could be identified before the development and clinical recognition of the disease phenotype of left ventricular (LV) hypertrophy (LVH) (25). Higher myocardial collagen content and interstitial myocardial fibrosis have been documented in cats with preclinical HCM compared to healthy cats, suggesting a profibrotic state plays a role in the pathogenesis of disease before onset of clinical signs (26). Biomarkers of collagen metabolism in ragdoll cats have been shown to correlate with the presence of the MYBPC3:R820W gene mutation (27). Whether biomarkers of collagen metabolism are altered in a hospital population of cats of various breeds with clinical HCM compared to healthy controls has not been reported.

Echocardiography is the diagnostic test of choice for establishing a diagnosis of HCM in cats (1,2). The echogenicity (acoustic brightness) of myocardium can be altered by infiltrative diseases such as neoplasia and amyloid, or by fibrosis. An increase in echogenicity has been demonstrated in the hearts of dogs (28,29), rabbits (29), rats (30), and humans (31,32) in association with increased collagen content (fibrosis) resulting from myocardial infarction. In this context, myocardial echogenicity increases with time: infarcted myocardium can remain isoechoic for 1 wk after the onset of infarction and then become hyperechoic over the following 2 wk (30). The increase in echogenicity is associated with a change in collagen fiber morphology, with thin collagen fibers predominating initially, followed by a predominance of thick fibers later (30). Thus, myocardial hyperechogenicity is less likely to be clinically useful as a marker of acute myocardial infarction, and rather could be a marker of chronic heart disease. Such a marker could be useful in feline cardiology because the echocardiographic diagnosis of HCM can be challenging in some cats with equivocal LV measurements (2). Although fibrosis is a hallmark of feline

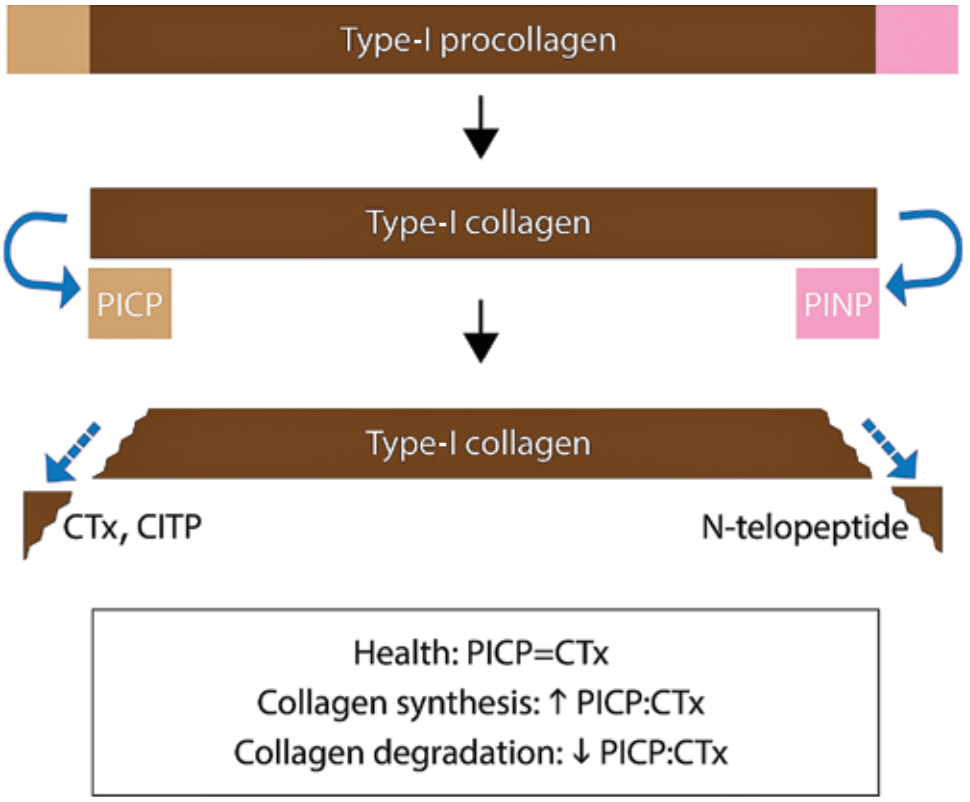

Figure 1. Extension domains of normal collagen turnover.

CITP – Carboxyterminal telopeptide of Type-I collagen including a terminal helical segment; CTx – Carboxyterminal telopeptide of Type-I collagen lacking a terminal helical segment; PICP – Carboxyterminal propeptide of Type-I procollagen; PINP – Aminoterminal propeptide of Type-I procollagen.

HCM histologically (33), the presence or absence of myocardial hyperechogenicity has not been described systematically in cats with or without HCM.

We proposed to investigate whether an association could be detected between the presence of HCM and serum concentrations of a biomarker of collagen degradation (CTx) in cats presented to a veterinary teaching hospital for cardiovascular evaluation. Furthermore, we sought to assess whether a higher prevalence of cardiac LV myocardial hyperechogenicity (suggesting myocardial fibrosis, and thus, increased collagen content) could be detected echocardiographically in cats with HCM compared to normal cats; and if so, whether it was associated with serum concentrations of CTx. We hypothesized that there would be a difference in serum CTx concentrations between cats with an echocardiographic diagnosis of HCM and cats with a normal echocardiogram. We also hypothesized that the prevalence of LV myocardial hyperechogenicity would be greater in cats with HCM than in normal cats, and that cats with LV hyperechogenicity would have higher serum CTx concentrations compared to those of normal cats.

Materials and methods

Animals

The study protocol was approved by the Animal Care Committee at the Atlantic Veterinary College, University of Prince Edward Island. Informed, signed owner consent was obtained for each cat. Cats were enrolled in the study upon presentation to the cardiology service at the Atlantic Veterinary College, University of Prince Edward Island (Charlottetown, Prince Edward Island).

For each cat, physical examination, echocardiogram, and systemic blood pressure measurement using a Doppler unit were completed. A complete blood (cell) count (CBC), biochemical panel, and thyroxine concentration were obtained if not recently done by the primary veterinarian. Inclusion criteria included an echocardiographic diagnosis of either HCM or no structural heart disease. Reasons prompting cardiac evaluation included evaluation of an incidental murmur or arrhythmia, routine monitoring of previously diagnosed HCM, dyspnea, and breed screening. Cardiovascular exclusion criteria were an echocardiographic diagnosis of heart disease other than HCM, serum thyroxine hormone concentration above the upper limit of the reference interval (44 nmol/L) or Doppler-derived systolic arterial blood pressure $>$ 160 mmHg. Other exclusion criteria were uncooperative behavior that prevented echocardiographic evaluation and atraumatic phlebotomy, and owner-reported clinical signs or physical examination findings consistent with any disease potentially indicating inflammation or fibrosis. These included a history of or current azotemia; a positive feline leukemia virus or feline immunodeficiency virus ELISA result; overt skeletal lesions; and clinical or laboratory findings that, in the opinion of the lead investigator (EA), could indicate inflammation. Control animals had no appreciable abnormalities on physical examination, CBCs, serum biochemical panels, or thyroxine concentrations.

Echocardiography

Echocardiography was done on each cat using either a 7 MHz sector array or an 8 MHz curvilinear array probe to conduct standard 2-dimensional (2D), M-mode, color, and spectral Doppler evaluations (LOGIQ 7; GE Healthcare, Wauwatosa, Wisconsin, USA). Each echocardiogram was conducted by a veterinary cardiologist Board-certified by the American College of Veterinary Internal Medicine (ACVIM) or a cardiology resident under the direct supervision of an ACVIM Board-certified veterinary cardiologist. The diagnosis of HCM was made when ≥ 1 segments of the interventricular septum (IVS) or LV free wall (LVFW) exceeded a thickness of 5.5 mm in diastole (2). Cats were assessed as having no echocardiographic evidence of structural heart disease (and assigned to the control group) when the IVS and LVFW were uniformly < 5.5 mm in thickness; left atrial to aortic ratio (LA:Ao) was < 1.5; LV and right ventricular outflow velocities were < 2 m/s; and there was no 2D, M-mode, or Doppler evidence of structural cardiac lesions. One investigator (EC) reviewed available echocardiograms after data acquisition for all cats had been completed, blinded to echocardiographic diagnoses and serum CTx concentrations. From these images, the investigator subjectively determined whether or not LV myocardial hyperechogenicity was apparent and, when it was present, noted its distribution. Left ventricular myocardial hyperechogenicity was defined as a greater-than-expected acoustic brightness of part or all of the LV, notwithstanding the normal, expected differences in echogenicity caused by far-field enhancement and echo dropout.

Serum biomarker

Blood samples were obtained at the time of cardiac imaging by phlebotomy of the jugular or saphenous vein using a 3-milliliter syringe and 22- or 25-gauge needle. Blood was immediately transferred to an additive-free tube (Becton-Dickinson, Mississauga, Ontario) and allowed to clot at room temperature for ≤ 20 min. Samples were centrifuged (Clinical Centrifuge Model 428; International Equipment Company, Needham Heights, Massachusetts, USA) at 3000 rotations/min (1470 *g*) for 15 min. Following centrifugation, serum was decanted into 2-milliliter polypropylene microcentrifuge tubes in 100-microliter aliquots and stored at −80°C prior to batch analysis. Samples not immediately transferrable to the −80°C storage unit were stored at 4°C for < 12 h. Serum samples then were batch-analyzed using a commercially available ELISA for CTx (Serum CrossLaps ELISA; Nordic Bioscience Diagnostics, Herlev, Denmark) previously validated for use in cats (34).

Statistical analysis

Statistical analysis software (Minitab; Minitab, State College, Pennsylvania, USA and Prism; GraphPad, La Jolla, California, USA) was used for graphical evaluation of data sets and execution of statistical tests. Data sets collected for echocardiographic variables and serum concentrations of CTx were examined graphically and *via* the Anderson-Darling normality test. Descriptive data are reported as mean ± standard deviation and range for continuous variables with data fitting a normal distribution. Between-group comparisons of data sets fitting a normal distribution following square root transformation were done using a 2-sample *t*-test. Data sets for variables that failed to fit a normal distribution, including after log and square root transformation, were compared between groups using Mann-Whitney tests and reported as median [1st and 3rd quartiles (25 to 75%)]. The number of cats with LV myocardial hyperechogenicity was compared to the number of cats without LV myocardial hyperechogenicity using Fisher's exact test. Statistical significance for all tests was defined as $P < 0.05$.

Results

Fifty-six cats were initially considered for the study. Nine cats were excluded: 6 for uncooperative behavior that precluded atraumatic phlebotomy; 3 for echocardiographic diagnoses of restrictive cardiomyopathy, ventricular septal defect, and mitral valve dysplasia (each $n = 1$). The remaining 47 cats constituted the study population: 28 with an echocardiographic diagnosis of HCM and 19 healthy cats designated as normal controls (N group). The mean age of all enrolled cats was 7.0 ± 3.7 y (HCM: 8.1 ± 3.5 y, range: 2 to 16 y; N: 5.3 ± 3.5 y, range: 1.5 to 15 y). Cats in the HCM group were significantly older than cats in the N group ($P = 0.01$). There were 31 castrated males, 15 spayed females, and 1 intact female. This combined group included 29 domestic shorthair cats, 11 domestic longhair cats, 2 ragdolls, 2 Bengals, and 1 each of the following breeds: rex, Maine coon, and Russian tabby. Four of twenty-eight cats with HCM (14%) were concurrently diagnosed with congestive heart failure at the time of evaluation.

Echocardiography

By definition, the HCM group had larger IVS and LVFW measurements than the N group (both $P < 0.01$) (Table 1). The HCM group also had a larger LA:Ao than the N group, measured in both 2D ($P < 0.01$) and M-mode ($P < 0.01$). There were no significant differences between the HCM and N groups for measurements of LV fractional shortening ($P = 0.52$) or in the diameter of the LV in either systole ($P = 0.28$) or diastole ($P = 0.25$).

Echocardiograms were available for post-hoc review in 43 cats. Left ventricular myocardial hyperechogenicity was apparent in 18 cats: 15/25 cats with HCM (60%) and 3/18 cats in the N group (17%) ($P = 0.0057$) (Figure 2). The LV myocardial hyperechogenicity affected the papillary muscles ($n = 5$), interpapillary muscle or peripapillary muscle segments of the LV free wall ($n = 6$), or both ($n = 2$); the interventricular septum ($n = 4$); the LV free wall diffusely ($n = 1$); or the left ventricle diffusely ($n = 4$) (total > 18 because, in some cats, > 1 region of the LV was hyperechoic).

Serum biomarker

The median serum concentration of CTx in the HCM group was 0.248 (25 to 75%, 0.146 to 0.483) ng/mL. The median serum concentration of CTx in the N group was 0.253 (25 to 75%, 0.184 to 0.56) ng/mL. There was no difference in serum CTx concentration between groups ($P = 0.4$).

The median serum concentration of CTx in cats with LV myocardial hyperechogenicity was 0.253 (25 to 75%, 0.183 to

Table 1. Echocardiographic measurements in cats with hypertrophic cardiomyopathy (HCM) *versus* normal controls (N).

	HCM (n = 28)	N (n = 19)	P-value
IVSd (mm)	5.1 (1.2)	4.1 (0.5)	< 0.01
IVSs (mm)	7.2 (1.1)	5.7 (0.8)	< 0.01
LVIDd (mm)	14.6 (2.8)	15.4 (2.3)	0.25
LVIDs (mm)	8.3 (0.2)	9.0 (0.1)	0.28
LVFWd (mm)	5.8 (1.4)	4.3 (0.6)	< 0.01
LVFWs (mm)	7.7 (1.5)	5.9 (0.7)	< 0.01
FS (%)	42.6 (8.5)	41.0 (8.4)	0.52
IVSLax1 (mm)	5.1 (0.8)	4.2 (0.5)	< 0.01
IVSLax2 (mm)	6.3 (5.4 to 6.8)	3.9 (3.5 to 4.5)	< 0.01
LVFWLax (mm)	6.8 (1.0)	4.2 (0.5)	< 0.01
IVSSax1 (mm)	5.8 (0.8)	3.9 (0.5)	< 0.01
IVSSax2 (mm)	5.9 (0.8)	4.0 (0.5)	< 0.01
LVFWSax (mm)	6.5 (0.9)	4.1 (0.6)	< 0.01
LA:Ao (2D)	1.4 (1.2 to 1.8)	1.2 (1.1 to 1.3)	0.0005
LA:Ao (M-mode)	1.4 (1.3 to 1.8)	1.2 (1.1 to 1.3)	0.0001

Values are reported as means (standard deviation) for normally distributed results and as medians (25th to 75th percentiles) for non-normally distributed results. FS — Fractional shortening; IVSd — Interventricular septal thickness in diastole, M-mode; IVSLax1 — Basal interventricular septal thickness in diastole as viewed in long axis, 2D; IVSLax2 — Mid-interventricular septal thickness in diastole as viewed in long axis, 2D; IVSs — Interventricular septal thickness in systole, M-mode; IVSSax1 — Left interventricular septal thickness in diastole as viewed in short axis at the papillary muscle level, 2D; IVSSax2 — Right interventricular septal thickness in diastole as viewed in short axis at the papillary muscle level, 2D; LA:Ao — Left atrial to aortic ratio; LVFWd — Left ventricular free wall thickness in diastole, M-mode; LVFWs — Left ventricular free wall thickness in systole, M-mode; LVFWLax — Basal left ventricular free wall thickness in diastole as viewed in long axis, 2D; LVFWSax — Basal left ventricular free wall thickness in systole as viewed in short axis, 2D; LVIDd — Left ventricular internal diameter in diastole, M-mode; LVIDs — Left ventricular internal diameter in systole, M-mode.

0.492) ng/mL. The median serum concentration of CTx in cats without LV myocardial hyperechogenicity was 0.253 (25 to 75%, 0.14 to 0.556) ng/mL. There was no difference in serum CTx concentration between groups (P = 0.93).

Discussion

The lack of a significant difference in serum CTx concentration in cats with HCM and cats with normal echocardiograms offers no support for excessive collagen degradation in cats with HCM. This finding refuted the first hypothesis of the study. Similarly, in human HCM patients, Ho *et al* reported no difference in the concentrations of ICTP between HCM mutation carriers with and without phenotypic expression of LVH (25). In those patients, the higher PICP:ICTP ratio, a reflection of the balance between collagen synthesis and degradation, implied excessive collagen synthesis rather than altered collagen degradation. The results of the present study support investigating whether this situation also exists in cats with HCM.

The lack of difference in serum CTx concentration between cats with HCM and normal controls contrasts with the findings of Borgeat *et al,* which showed that mutation-positive ragdoll cats had higher serum concentration of CITP than did mutation-negative normal controls (27). Without a marker for Type-I collagen synthesis in that study, it is not clear if that finding occurred due to greater collagen degradation or a change in overall collagen metabolism in mutation carriers. The results of the present study did not document a different serum concentration between affected and healthy cats. Various explanations may account for this difference. First, Type-I collagen degradation could be more common in early stages of HCM, then slow after the development of LVH. If so, then the mutation carriers in the

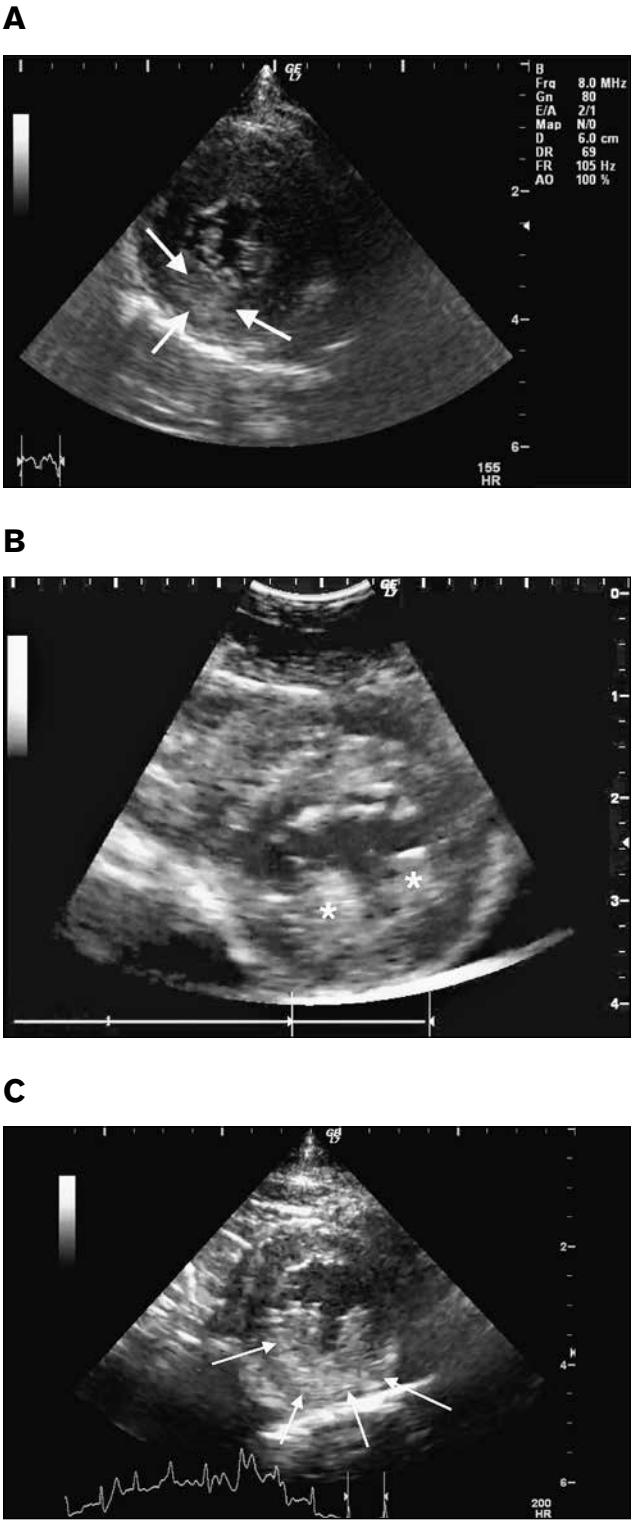

Figure 2. Examples of left ventricular (LV) myocardial hyperechogenicity. Right parasternal short-axis views, mid-ventricular level. A – Well-circumscribed increase in echogenicity (arrows) affecting the LV, between the papillary muscles, extending from the subendocardium through most of the thickness of the LV free wall. B – Increase in echogenicity of both papillary muscles (asterisks) beyond the expected increase that occurs normally from far-field enhancement (see Video S1, available online from: www.canadianveterinarians.net). C – Increase in echogenicity (arrows) of much of the LV free wall, predominantly affecting the subendocardial region (see Video S2, available online from: www.canadianveterinarians.net).

study from Borgeat *et al* who had not developed LVH would be expected to have higher CITP concentrations than would the cats with LVH. A second possible explanation for the difference between results of the present study and those of Borgeat *et al* is statistical underpowering of the present study. This seems less likely, as the present study involved 28 cats with HCM and no statistically significant difference in CTx concentration in these cats compared to controls, whereas the Borgeat *et al* study involved 25 cats with HCM with a significant difference reported compared to controls. Third, CITP and CTx are closely-related but distinct C-terminal telopeptide byproducts of Type-I collagen degradation (Figure 1), and a difference in the kinetics of their formation, or in assay performance, could explain the difference in results between the present study and that of Borgeat *et al.* A final possible explanation for the differences in results between studies is population composition. The study by Borgeat *et al* exclusively enrolled ragdoll cats in which the genetic mutation could be evaluated, whereas the present study included cats from 7 different breeds without genetic evaluation. Feline breed- or mutation-specific alterations in collagen metabolism have not been reported but could contribute to differences between these 2 studies. Additionally, affected cats in the present study were significantly older than normal controls, whereas the mutation carriers in the study from Borgeat *et al* were not different in age from normal controls. If collagen degradation is influenced by age, this might explain the discordant results in serum CTx concentrations between studies. DeLaurier *et al* reported that urine and serum CTx concentrations were inversely correlated with age in healthy cats; cats < 1 y of age had significantly higher CTx concentrations than did cats > 1 y of age (34,35). As CTx is not specific for myocardial collagen degradation, this was thought to reflect more rapid bone metabolism in growing animals, which stabilized with skeletal maturity.

The higher prevalence of LV myocardial hyperechogenicity in cats with HCM compared to controls supported the second hypothesis of this study. Increased LV myocardial echogenicity has been described subjectively in individual cats and is a well-known association with HCM (36), but is not routinely included in detailed descriptions of echocardiographic findings in cats with HCM (2). The significant difference in the present study between the prevalence of LV myocardial hyperechogenicity in HCM (60%) cats compared to cats in the N group (17%) suggests that evidence of myocardial fibrosis could be detectable echocardiographically in cats with HCM. The heterogeneity of phenotypic manifestations of HCM in cats means that having an additional echocardiographic finding associated with it, such as myocardial hyperechogenicity, could increase the suspicion of HCM when other data do not provide a clear answer. The presence of LV myocardial hyperechogenicity affecting the papillary muscles in 13/18 cats (72%) is consistent with these structures being the farthest removed of any part of the LV from a coronary arterial supply that is located epicardially, and thus, possibly at greater risk of ischemia in HCM. Although confirmation of fibrosis would require histopathologic evaluation of myocardium, measurements of serum CTx concentrations could have been a surrogate for assessing this variable. However, in this study population, no association was determined. The lack of a difference in serum CTx concentrations between cats with and those without LV myocardial hyperechogenicity refuted the third hypothesis of this study. Possible explanations for this result could include an alternative cause of such hyperechogenicity or poor assay performance.

This study had limitations that present areas warranting future investigation. First, entry criteria included a conservative cutoff for LV mural dimensions, which could cause Type 1 error by including cats in the HCM group that did not have HCM. Second, although the review of echocardiograms was done with the investigator unaware of the group assignment of each cat, echocardiographic images could be suggestive of HCM (or its absence) and thus could influence the investigator, despite blinding. Third, myocardial hyperechogenicity was assessed subjectively; in future studies, backscatter measurements could be used for a quantitative assessment of this finding (29,31), and interobserver variability could be investigated.

In conclusion, in this study — and in contrast to previous work in cats, but consistent with that in humans — cats with HCM did not have significantly different serum CTx concentrations than normal control cats. Left ventricular myocardial hyperechogenicity was more prevalent in cats with HCM than in normal controls. Serum CTx concentrations were not associated with LV myocardial hyperechogenicity. Evaluation of myocardial fibrosis in cats remains a worthwhile pursuit, particularly as evidence mounts that the presence and extent of myocardial fibrosis are negative prognostic indicators in humans with HCM.

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Sepsis-induced cardiomyopathy in animals: From experimental studies to echocardiography-based clinical research

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Abstract — The term "sepsis-induced cardiomyopathy" (SIC) is used to describe transient cardiac dysfunction in septic patients. However, there is no universally accepted definition of SIC; a reduction in left ventricular ejection fraction (LVEF) is often used. In addition to systolic dysfunction, diastolic dysfunction is now recognized as an essential component of SIC. It can be emphasized that previous animal experiments played an essential role in revealing SIC and hemodynamic instability in sepsis and septic shock. The diagnostic and prognostic capabilities of echocardiography for the assessment of SIC have been extensively studied since its introduction into intensive care clinical practice. Recent studies in dogs, calves, and horses have shown that left and right ventricular systolic dysfunction, left ventricular diastolic dysfunction, and circulatory dysfunction can occur in sepsis, severe sepsis, and septic shock in animals. Echocardiographic variables have also shown that indices of left and right ventricular dysfunction and circulatory failure are valuable indicators of mortality in septic animals.

Résumé — Cardiomyopathie induite par la septicémie chez l'animal : des études expérimentales à la recherche clinique basée sur l'échocardiographie. Le terme « cardiomyopathie induite par la septicémie » (SIC) est utilisé pour décrire un dysfonctionnement cardiaque transitoire chez les patients septiques. Cependant, il n'y a pas de définition universellement acceptée du SIC; une réduction de la fraction d'éjection ventriculaire gauche (FEVG) est souvent utilisée. En plus de la dysfonction systolique, la dysfonction diastolique est maintenant reconnue comme une composante essentielle du SIC. On peut souligner que les expérimentations animales antérieures ont joué un rôle essentiel dans la révélation du SIC et de l'instabilité hémodynamique dans la septicémie et le choc septique. Les capacités diagnostiques et pronostiques de l'échocardiographie pour l'évaluation du SIC ont été largement étudiées depuis son introduction dans la pratique clinique des soins intensifs. Des études récentes sur des chiens, des veaux et des chevaux ont révélé qu'un dysfonctionnement systolique ventriculaire gauche et droit, un dysfonctionnement diastolique ventriculaire gauche et un dysfonctionnement circulatoire peuvent survenir dans la septicémie, la septicémie sévère et le choc septique chez les animaux. Les variables échocardiographiques ont également démontré que les indices de dysfonctionnement ventriculaire gauche et droit et d'insuffisance circulatoire sont des indicateurs précieux de la mortalité chez les animaux septiques.

(Traduit par Dr Serge Messier)

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Introduction

It has been almost 400 y since William Harvey (1578–1657) discovered that the heart plays the most important role in the circulatory system (1). However, our knowledge of the heart and circulatory system was limited at that time; today, we have a better understanding of how this system functions, especially in health and disease. The term "sepsis-induced cardiomyopathy" (SIC), or "septic cardiomyopathy" (SC), was systematically proposed by Parker and colleagues in 1984 (2), and it can be emphasized that animal experiments played an important role in revealing the hemodynamic instability of sepsis and septic shock. Therefore, in this review, we have tried to address the significant developments in the diagnosis and evaluation of SIC and hemodynamic instability in septic animals, from experimental studies to clinical research.

Experimental studies to explore septic cardiomyopathy in animals

Prior to the introduction of pulmonary arterial catheterization (PAC) into hemodynamic studies of septic humans and animals,

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sepsis was described as having hyperdynamic and hypodynamic phases. Based on this, Weil *et al* (3) and Postel and Schloerb (4), using intravenous bolus injections of high doses of endotoxin or live organisms, showed septic shock characterized by reduced cardiac output (CO) and systemic vascular resistance (SVR) that led to animal death. Cardiovascular dysfunction in sepsis is better understood with the use of pulmonary artery thermodilution catheters, which allow measurement of both CO and pulmonary artery wedge pressure (PAWP). Animal studies in monkeys (5), rabbits (6), and dogs (7–9) have clearly shown that CO is higher and SVR is lower in cardiopulmonary-resuscitated individuals than in non-resuscitated individuals. In light of these data, it can be concluded that the description of low CO in septic shock patients was most likely due to hypovolemia. It is now generally accepted that severe sepsis and septic shock are often associated with high CO after adequate volume loading (10).

However, there is no universally accepted definition of SIC; a reduction in left ventricular ejection fraction (LVEF) is often used (11,12). The concept of SIC was first described by Parker and colleagues, using serial radionuclide cineangiography and simultaneous thermodilution CO as a reversible myocardial depression in patients with septic shock (2). They showed that 15 of 20 patients with septic shock had depression of LVEF during the first 2 d after the onset of septic shock. Interestingly, the survivors had a lower LVEF for 4 d and then recovered to typical values within 7 to 10 d. Acute left ventricular (LV) dilatation was also observed in these resuscitated patients with septic shock, and these acute changes in ventricular volume were reversible within 7 to 10 d in survivors.

Although early studies demonstrated a reduction in LV systolic function, experimental studies in canine septic shock models have shown that both left and right ventricular (RV) function can be impaired during the onset of sepsis and endotoxemia induced by *Escherichia coli* or *Staphylococcus aureus* (8,9,13,14). In the canine septic shock model, Natanson *et al* (8) also confirmed that LVEF was reduced in septic animals. The maximum decrease in LVEF occurred on Day 2, remained depressed for 2 to 3 d, and recovered by 7 to 10 d.

In addition to canine models of sepsis, an experimental study of acute endotoxemia in neonatal calves investigated the acute effects of endotoxemia on LV contractility, relaxation, diastolic properties, and mechanical energetics. The results after endotoxin infusion showed increased heart rate (HR), mean pulmonary artery pressure (PAP), LV contractility (end-systolic elastance), chamber stiffness, and mechanical efficiency; no change in LV relaxation; and decreased mean systemic arterial pressure, CO, and LV stroke work and pressure-volume area. The results indicated that, in neonatal calves, LV systolic performance is sufficient during 4 h of endotoxemia; and systemic hypotension, pulmonary arterial hypertension (PAH), and vascular volume depletion are the main causes of cardiovascular dysfunction during acute endotoxemia in calves (15).

The echocardiography-based exploration of septic cardiomyopathy in animals

Although not perfect, PAC has long been considered the optimal form of hemodynamic monitoring because it allows almost continuous, simultaneous recording of pulmonary artery and cardiac filling pressures and CO. The diagnostic and prognostic capabilities of echocardiography for the assessment of SIC have been extensively studied since its introduction into clinical practice (16,17) (Figure 1). In addition, echocardiography is increasingly used for hemodynamic monitoring and titration of therapy in septic shock (18,19).

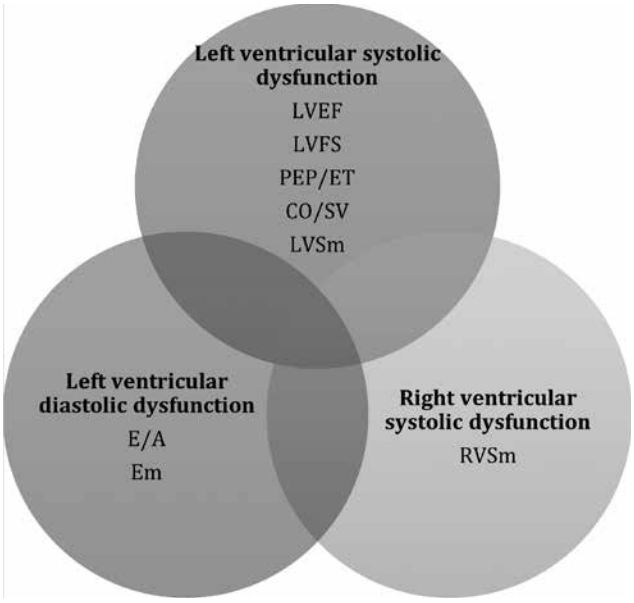

Figure 1. Types of sepsis-induced cardiomyopathies and the most commonly used echocardiographic indices in animal studies.

LVEF – Left ventricular ejection fraction; LVFS – Left ventricular fractional shortening; PEP – Pre-ejection period; ET – Ejection time; CO – Cardiac output; SV – Stroke volume; LVSm – Septal mitral annulus systolic velocity; E/A – Ratio of mitral inflow peak early diastolic filling velocity (E) and mitral inflow peak late diastolic filling velocity (A); Em – Septal-mitral annulus early diastolic velocities; RVSm – Right ventricular tricuspid annulus systolic velocity.

The first clinical trials and case reports: The beginning of the journey

To the best of our knowledge, the first clinical study involving echocardiographic assessment of myocardial dysfunction in animals was conducted by Nelson and Thompson (20) in 16 critically ill dogs (Table 1). They used percent LV fractional shortening (FS), LV pre-ejection period (PEP), and PEP compared to ventricular ejection time (ET) to define LV systolic dysfunction, and the ratio of mitral valve inflow velocities (E and A) to assess LV diastolic dysfunction. They reported that 6 dogs had increased PEP/ET, 3 had diastolic dysfunction, and 3 had subnormal CO. The most common diagnoses in dogs with critical illness and LV dysfunction were bacterial sepsis (n = 5) and cancer (n = 5). Of the 16 dogs evaluated, 12 (75%) died or were euthanized within 15 d of hospitalization. The authors concluded that detection of LV dysfunction in critically ill dogs may be a poor prognostic indicator, particularly in dogs with sepsis and cancer. Early identification and treatment of ventricular dysfunction may limit morbidity and mortality in these critically ill dogs (20).

Table 1. Key echocardiographic findings of sepsis-induced cardiomyopathy in different species, and techniques used.

Authors	Echocardiographic techniques	Species	Key findings
Nelson and Thompson, 2006 (20)	M-mode, PW-Doppler	Dog	LV systolic and diastolic dysfunction, decreased CO.
Dickinson *et al,* 2007 (21)	M-mode	Dog	Dilated and hypokinetic LV, dilated RV.
Nakamura *et al,* 2012 (22)	2D, M-mode	Dog	Decreased LVEF and LVFS.
Naseri *et al,* 2018 (23)	2D, M-mode	Calf	Profoundly reduced LVEF, decreased CI.
Erturk *et al,* 2018 (24)	2D, M-mode, CW-Doppler	Calf	Hypokinetic LV, decreased CI, dilated RV.
Borde *et al,* 2011 (25)	2D, M-mode, PW-Doppler	Horse	Decreased SV, ET, AoVTI. No change in LVEF and LVFS.
Kocaturk *et al,* 2012 (26)	PW-Doppler	Dog	High Tei index for non-survivors. Low LVFS and LVEF in non-survivors.
Borde *et al,* 2014 (27)	2D, M-mode, PW-Doppler, TDI	Horse	Decreased Em and PEP/ET; increased E/Em, ET, and SV in non-survivors.
Ince *et al,* 2019 (28)	2D, M-mode, PW-Doppler, TDI	Dog	High Sm and LVEF, low Em and E/A in non-survivors.
Akar, 2019 (29)	2D, M-mode, PW-Doppler, TDI	Dog	Decreased RVSm and LV Em in non-survivors.
de Abreu *et al,* 2021 (30)	2D, PW-Doppler, TDI, speckle tracking	Dog	Impaired global longitudinal St and SR. Impaired global circumferential St and SR.
Corda *et al,* 2019 (31)	2D, M-mode, speckle tracking	Dog	Decreased LV longitudinal endomyocardial shortening. No change in LVEF and LVFS.
Naseri *et al,* 2019 (32)	2D, M-mode	Calf	Slightly decreased LVEF and LVFS. Decreased CI.
Ince *et al,* 2021 (33)	2D, M-mode, PW-Doppler, TDI	Dog	Decreased LV E/A and Em. No change in LVEF.
Suleymanoglu *et al,* 2023 (35)	2D, M-mode, PW-Doppler, TDI	Dog	Isolated LV diastolic dysfunction (Em) was common.

M-mode — Time motion mode; PW-Doppler — Pulsed-wave Doppler; LV — Left ventricular; CO — Cardiac output; RV — Right ventricle; 2D — Two-dimensional; LVEF — Left ventricular ejection fraction; LVFS — Left ventricular fractional shortening; CI — Cardiac index; CW — Continuous wave Doppler; SV — Stroke volume; ET — Ejection time; AoVTI — Aortic velocity time integral; TDI — Tissue Doppler imaging; Em — Septal-mitral annulus early diastolic velocities; PEP/ET — LV pre-ejection period to ejection time; E — Mitral inflow peak early diastolic filling velocity; A — Mitral inflow peak late diastolic filling velocity; Sm — Septal mitral annulus systolic velocity; RVSm — Tricuspid annulus systolic velocity; St — Strain; SR — Strain rate.

Echocardiography confirmed a clinical case of reversible SIC first described by Dickinson *et al* (21) in the setting of deciduous tooth eruption and development of sepsis in a 5-month-old dog. Echocardiography was done after adequate fluid therapy and indicated a dilated hypokinetic LV, increased end-systolic volume index (ESVI), dilated RV, and increased E point of septal separation (EPSS). Three months after resolution of sepsis, echocardiography revealed good LV systolic function and normal cardiac dimensions. The ESVI had decreased to the reference range. The authors concluded that the likely cause of the reversible myocardial depression was sepsis and that all abnormal findings resolved with time and correction of sepsis and SIC should be considered in dogs with sepsis (21).

Similarly, reversible myocardial depression is reported in the manuscript by Nakamura *et al* (22) in an 11-month-old dog referred for management after cardiopulmonary arrest (CPR). The time-motion (M-mode) echocardiographic findings revealed increased LV intraventricular systolic and diastolic dimensions (LVIDs and LVIDd, respectively) and decreased LVEF and left ventricular fractional shortening (LVFS) on admission. After hospitalization and a second echocardiographic examination on Day 4, LVIDs, LVIDd, LVEF, and LVFS were normal. However, the exact pathophysiology of myocardial dysfunction after resuscitation is unclear; the authors speculated that increased myocardial microvascular permeability and cardiac edema in CPA, mitochondrial oxidative phosphorylation deficiency, and myocardial dysfunction secondary to systemic inflammatory response syndrome (SIRS) could lead to myocardial depression in this case (22).

In addition to the use of echocardiography to identify myocardial dysfunction in small animals, the same features have been identified in large animals. The first clinical case of SIC in a calf with septic shock was described by Naseri *et al* (23) in a 10-day-old calf with diarrhea. M-mode echocardiographic findings at the time of admission showed increased LVIDs and LVIDd, decreased cardiac index (CI) and stroke volume (SV), and severely reduced LVEF. The second echocardiogram, done at 24 h of sepsis treatment, showed decreased LVIDs and LVIDd and increased CI, SV, and LVEF (Figure 2). Despite intensive therapy, the calf died the next morning. The authors concluded that myocardial depression may be reversible in the calf with septic shock, but traditional indices such as LVEF, CI, and SV may be inaccurate because they are influenced by changes in HR, preload, and afterload. Thus, a decreased ESVI may indicate vasodilation, and a decreased end-diastolic volume index (EDVI) may indicate hypovolemia. These were the major implications of sepsis and led to multiple organ dysfunction and death in the present case (23).

Similarly, LV systolic dysfunction and right heart failure in a neonatal calf due to sepsis was reported by Erturk *et al* (24) in a 14-day-old calf. Echocardiographic findings included hypokinetic LV and decreased SV and CI. There was also a dilated RV and right atrium (RA). Systolic pulmonary arterial pressure, estimated by tricuspid regurgitation, showed moderate pulmonary

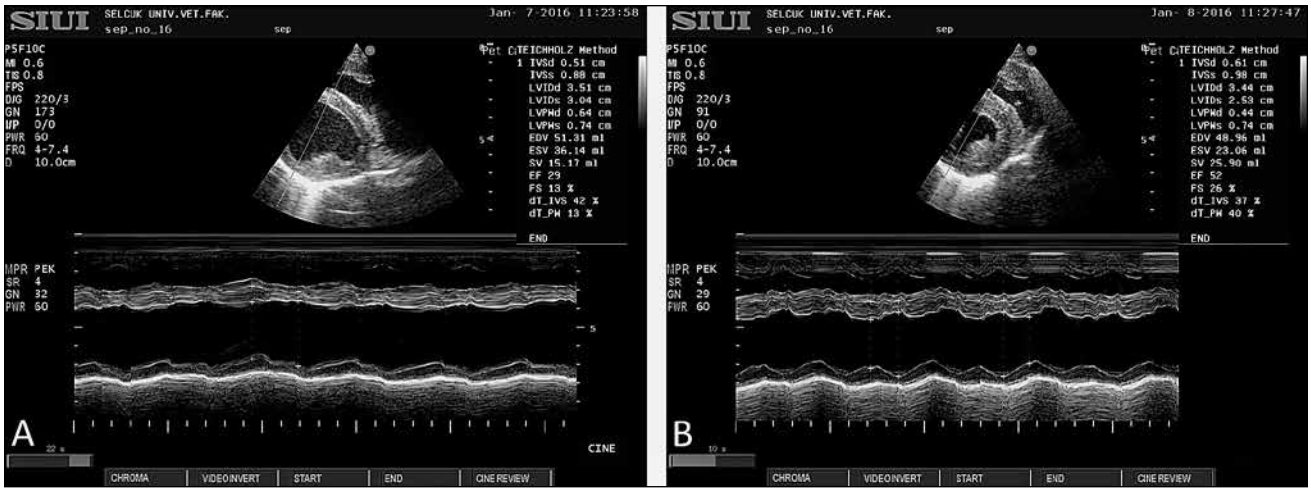

Figure 2. Echocardiography. A – Hypokinetic left ventricle and decreased left ventricular ejection fraction, stroke volume, and cardiac index in a calf with sepsis. B – Image from the same calf at 24 h after fluid resuscitation. Improvement in systolic contractile function of the left ventricle by increasing left ventricular ejection fraction, stroke volume, and cardiac index (Naseri *et al,* 2018) (23).

hypertension (46 mmHg). Ultrasonographic findings included hepatomegaly and congestion, with increased echogenicity of the parenchyma, and the caudal vena cava was dilated and did not collapse during inspiration. The authors also determined high serum levels of creatine kinase-MB and cardiac troponin I. They suggested that sepsis may be the main cause of LV systolic dysfunction and pulmonary hypertension in this case.

The start of using Doppler methods

The effect of colic-induced endotoxin shock on cardiac function in horses was studied by Borde *et al* (25). In this study, to evaluate LV function in 50 horses, the measured and calculated echocardiographic variables were derived from 2-dimensional (2D), M-mode, and pulsed-wave Doppler (PW-Doppler) methods. All significantly lower were EDVI, ESVI, SV, stroke index (SI), ET, ejection time index corrected for heart rate (ETHR), aortic velocity time integral (AoVTI), aortic flow acceleration time, and aortic flow deceleration time. In contrast, aortic flow ejection acceleration time and HR were significantly higher in horses with endotoxic shock compared to control horses. Changes in LVEF and LVFS remained insignificant in the study groups. The authors pointed out that the results obtained should be interpreted with caution since the echocardiographic findings are related to the hemodynamic alterations and the loading state of the heart (vasodilation and hypovolemia). Also, they suggest that echocardiographic parameters derived from PW-Doppler imaging may be more accurate than 2D and M-mode indices (25).

To fill the gap in the efficacy of load-dependent parameters, Kocaturk *et al* (26) combined 2D, M-mode and, Doppler echocardiography imaging techniques to assess LV function in canine parvovirus enteritis (PVE) with sepsis. In addition to systolic time intervals (PEP and ET), LVEF and LVFS, they calculated the Tei index (myocardial performance index), which combines systolic and diastolic time intervals to assess global ventricular function, and mitral inflow peak early diastolic filling velocity (E) and mitral inflow peak late diastolic filling velocity (A). The authors determined that the Tei index was significantly higher in non-surviving dogs than in surviving and control dogs. Lower FS and EF were observed in non-surviving dogs compared to surviving and healthy dogs. The E/A ratio of mitral inflow was significantly lower in non-surviving dogs than in surviving and control dogs. They also determined that the Tei index had 91% sensitivity and 100% specificity for predicting mortality in dogs with PVE at an optimal cutoff of > 0.8. The slight increase in PEP/ET ratio and decrease in FS and EF in dogs with PVE may be due to a decrease in myocardial contractility. The significant increase in Tei observed in non-surviving dogs was consistent with impaired systolic and diastolic function. The findings of increased PEP/ET, prolonged isovolumetric relaxation time (IVRT) and isovolumetric contraction time (ICT), and lower mitral E/A ratio support impaired ventricular relaxation and, consequently, diastolic dysfunction. The authors also demonstrated that the use of the Tei index may be of great importance in the diagnostic workup and prognostic evaluation of dogs with PVE in practice (26).

Tissue Doppler imaging

The study by Borde *et al* (27) in horses admitted for colic complicated by SIRS was the next development in echocardiography in septic animals. The authors evaluated LV systolic and diastolic function in surviving and non-surviving horses with suspected sepsis using standard transthoracic echocardiography (2D and M-mode), PW-Doppler, and tissue Doppler echocardiography (TDI). They determined that TDI septal-mitral annulus early diastolic velocities (Em) were significantly lower and mitral E/Em was significantly higher in non-survivors compared to survivors. In addition, AoVTI, deceleration time, and ET, SV, SI, and ETHR were significantly lower; and PEP/ET and mean circumferential fiber shortening velocity (Vcf) were significantly higher in non-survivors compared with survivors. A cutoff value of 2.67 for E/Em predicted mortality with 100% sensitivity

and 83% specificity. Other parameters related to LV systolic function, such as LVEF and LVFS, did not differ significantly between study groups. The results of this study indicated that echocardiographic markers of both systolic (SI, ET, PEP/ET) and diastolic (Em, E/Em) dysfunction predicted poor outcome in horses admitted with sepsis and suggested that echocardiography may provide useful prognostic information in these horses, as has been shown in human patients with septic shock (27).

The use of echocardiography to predict mortality

Accordingly, the work of Ince *et al* (28) in dogs with severe sepsis and septic shock established the prognostic value of LV systolic and diastolic dysfunction. Two-dimensional, M-mode, and transthoracic Doppler echocardiography was done in dogs with sepsis. The septic dogs were followed for 28-day mortality and divided into survivors and non-survivors. The authors determined that 75% of the dogs had at least one type of myocardial dysfunction. Systolic and diastolic dysfunction were present in 15% and 70% of dogs, respectively, and both types of dysfunction were present in 10% of dogs. They determined that impaired relaxation (grade 1) and pseudonormal dysfunction (grade 2) were the most common types of LV diastolic dysfunction in dogs with severe sepsis and septic shock. The authors also showed that septal-mitral annulus systolic velocity (LVSm), Em, LVEF, and mitral annulus E/A ratio were independent predictors of mortality. At admission, LVEF and Sm were significantly higher in non-surviving dogs than in surviving dogs, and mitral annulus E/A and Em were lower in non-surviving dogs than in surviving dogs. They also reported that Sm, an index of systolic dysfunction, had high sensitivity and specificity (83% and 83%, respectively) and an optimal cutoff of ≥ 9.90 to differentiate survivors from non-survivors. For diastolic dysfunction, Em was the most sensitive and specific (both 100%) index, with an optimal cutoff of ≤ 6.50 to differentiate survivors from non-survivors (28).

Right ventricle should not be neglected

The hypothesis of pulmonary hypertension and RV dysfunction in dogs with sepsis and septic shock was confirmed in a pilot study by Akar (29). Two-dimensional, M-mode, and transthoracic Doppler echocardiography were done in dogs with sepsis. To detect RV systolic dysfunction, tricuspid annulus systolic velocity (RVSm) was performed using TDI. The primary results showed that LV systolic dysfunction, LV diastolic dysfunction, and RV systolic dysfunction were present in 16%, 64%, and 60% of the dogs, respectively. Both types of dysfunction (LV diastolic dysfunction and RV systolic dysfunction) were present in 28% of the septic dogs. In addition, the prognostic value of Em and RVSm for 28-day mortality was evaluated. The RVSm, an index of RV systolic dysfunction, showed good sensitivity and specificity (87% and 82%, respectively) with a cutoff value of ≤ 8.88 to discriminate survivors from non-survivors. The Em, an index of diastolic dysfunction, was also the most sensitive and specific variable (100% and 94%, respectively) with a cutoff of ≤ 5.06 to estimate outcome in septic dogs. The author suggested that endothelial dysfunction in sepsis and increased pulmonary vascular resistance (PVR), suspected acute respiratory distress syndrome, and pulmonary embolism may lead to RV systolic dysfunction in dogs with sepsis and is associated with poor outcomes (29).

Advanced techniques: Speckle-tracking echocardiography

Recently, 2-dimensional speckle-tracking echocardiographic (2D-STE) variables have been used to assess myocardial function in dogs with canine parvovirus infection and dogs with SIRS. The previous study by de Abreu *et al* (30) was the first to use strain (St) and strain rate (SR) by 2D-STE to assess global and regional myocardial function in dogs with PVE during inflammation. The authors determined that global longitudinal St and SR were impaired at the endocardial and epicardial levels in all dogs with PVE. Global circumferential St and SR were impaired only at the endocardial level in all groups of dogs with PVE. Global epicardial circumferential St was impaired only in the PVE-dead group, whereas global epicardial circumferential SR remained normal in all groups. However, the results of standard echocardiographic variables showed that all variables were within reference ranges, and the impaired St and SR values in dogs with PVE indicated the presence of systolic myocardial dysfunction in infected animals. This dysfunction may have been caused by direct viral action and/or the effects of SIRS on the myocardium.

In another study, Corda *et al* (31) attempted to compare 2D-STE with 2D and M-mode echocardiography to assess systolic function in dogs with SIRS. They determined that mild-to-moderate stages of SIRS in dogs were associated with LV systolic impairment identified by 2D-STE, but not by 2D- and M-mode-derived EF and FS. The results of their investigation suggest that mild and moderate stages of SIRS in dogs affect LV longitudinal endomyocardial shortening without altering longitudinal epimyocardial or radial contraction. Ischemia, sepsis-induced microcirculatory changes, and inflammatory mediators may affect longitudinally oriented subendocardial myocytes, resulting in a decrease in endomyocardial longitudinal systolic shortening.

The emergence of the longitudinal studies

The first longitudinal evaluation of LV systolic dysfunction in animals was completed by Naseri *et al* (32) in neonatal calves with naturally occurring sepsis or septic shock due to diarrhea. Two-dimensional, M-mode, and systolic time intervals were evaluated in septic calves for 3 d after admission to the intensive care unit. They determined significant decreases in left ventricular EDVI, ESVI, stroke volume index (SVI), and CI on admission. The HR and other parameters of LV systolic function (ET, ETHR, PEP:ET, Vcf) were not significantly different between septic and healthy calves. The LVEF and LVFS were slightly increased in septic calves. After treatment initiation, the results showed that left ventricular EDVI, ESVI, SVI, CI and blood pressure (BP) significantly increased in septic calves within the first 6 h of treatment initiation. However, EDVI, SVI, and CI remained low and failed to reach the mean value for healthy calves despite ongoing fluid therapy. Ninety percent of the calves died during the hospitalization period.

Although one of the major limitations of the study was the lack of load-independent parameters of myocardial function, such as Doppler, the echocardiographic findings obtained suggest that circulatory dysfunction (decreased preload as manifested by low EDVI; decreased afterload as manifested by low ESVI), rather than systolic dysfunction, was the most clinically important cardiovascular abnormality in septic calves (32).

Recently, another longitudinal study of LV systolic and diastolic functions in dogs with severe sepsis and septic shock was completed by Ince *et al* (33) in dogs with PVE. Two-dimensional, M-mode, and Doppler echocardiographic indices of LV systolic and diastolic function were evaluated in this study. The authors did not find a significant difference in LVEF between the septic and healthy dogs. Mitral annulus E/A and Em in the dogs with sepsis decreased on admission compared to healthy dogs. The authors determined that LV systolic dysfunction, LV diastolic dysfunction, and both types of dysfunction were present in 13%, 70%, and 9% of dogs with sepsis, respectively. They concluded that dogs with LV diastolic dysfunction had worse outcomes and short-term mortality (1.3 ± 1.4 d).

Provide guidance on the treatment protocol

Early goal-directed therapy protocols have been developed to normalize irregular measurable indices of tissue perfusion and oxygenation (34). The first attempt to assess hemodynamic instability in dogs with severe sepsis and septic shock using a combination of macrovascular parameters, such as blood pressure, and echocardiographic indices of LV systolic and diastolic function was made by Suleymanoglu and colleagues (35). They used serial blood pressure measurements and transthoracic echocardiographic parameters in surviving and non-surviving septic dogs in response to targeted hemodynamic optimization and to evaluate the use of norepinephrine and dobutamine and their effectiveness in predicting death. The authors determined that, at the time of admission, 74% of septic dogs had at least one type of myocardial dysfunction, and 60% of septic dogs had both types. Isolated LV diastolic dysfunction was a more common type of dysfunction (46%). A total of 8 dogs with LV diastolic dysfunction and 1 dog with LV systolic dysfunction died. They also determined that the surviving and non-surviving dogs had no significant differences in macrovascular and microvascular characteristics; the only difference was in the amount of norepinephrine administered. The non-surviving dogs were given a greater amount of norepinephrine and the surviving dogs were given a lesser amount of norepinephrine. In contrast, survivors received more dobutamine.

Conclusion

Although our view of cardiovascular dysfunction and hemodynamic instability in animals is now more advanced and evolved, we should not forget that animal-based studies have undoubtedly made important contributions to the development of our knowledge in this area over the past decades. With the introduction of echocardiography in the intensive care unit and real-time monitoring of critically ill patients, especially those with sepsis, veterinarians gained more realistic information about the functioning of the cardiovascular system during sepsis and septic shock. The improvements in veterinary intensive care units also highlighted the idea that echocardiography could provide more advantages, helping to guide treatment characteristics (*e.g.,* fluid therapy, vasopressors, positive inotropes) and determine prognoses in septic animals. CVJ

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Answers to Quiz Corner
Corrigé du test éclair

1. B) This is an acute febrile transfusion reaction so you should discontinue the transfusion. Also, look for hemolysis — *e.g.*, pigmenturia or red coloration of serum in the hematocrit tubes. Hemolytic reactions are the most serious, and most rare, complication of blood transfusion.

Prevention: Perform blood-typing and crossmatch before any transfusion in a cat (and before a second transfusion in a dog or horse) to reduce the risk of a hemolytic transfusion reaction.

Discontinue a transfusion if there are any signs of a reaction. Diphenhydramine may help with a febrile, non-hemolytic transfusion reaction. If there is no hemolysis, then the transfusion can often be restarted. Do not continue if a hemolytic transfusion reaction is suspected.

During a blood transfusion, carefully and frequently monitor the animal for clinical signs consistent with a reaction.

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2. Silverstein DC, Hopper K. Small Animal Critical Care Medicine. 2nd ed. St. Louis, Missouri: Elsevier, 2015:333–337.

2. B) Bronchoalveolar lavage (BAL) reveals neutrophilic inflammation and mucus (Curschmann's spirals) in horses with recurrent airway obstruction (RAO). Also often called "heaves," this is part of the equine asthma complex.

Recurrent airway obstruction is the most common disease to consider when you examine an afebrile, older, stabled horse that is coughing or wheezing, with increased respiratory rate at rest. This is a chronic inflammatory airway disease exacerbated by dust, hay, and mold. Diagnosis is based on clinical signs plus BAL findings.

Treatment is primarily to decrease exposure to dust and hay. House the animal outside if possible (except for the less common cases of pasture-associated RAO), and administer bronchodilators (*e.g.*, albuterol/clenbuterol) plus corticosteroids. Therapy may be injectable, oral, *via* inhaler/nebulizer, or some combination of all these.

1. B) Il s'agit d'une réaction fébrile aiguë à la transfusion; cette dernière devrait donc être interrompue. Recherchez également une hémolyse – par exemple, une pigmenturie ou une coloration rouge du sérum dans les tubes à hématocrite. Les réactions hémolytiques sont la complication la plus grave, et la plus rare, de la transfusion sanguine.

Prévention : Déterminez le groupe sanguin et vérifiez la compatibilité avant toute transfusion chez un chat (et avant une deuxième transfusion chez un chien ou un cheval) afin de réduire le risque de réaction hémolytique à la transfusion.

Interrompez la transfusion si l'animal présente quelque signe de réaction que ce soit. La diphénhydramine peut aider lors d'une réaction fébrile non hémolytique à une transfusion. S'il n'y a pas d'hémolyse, on peut souvent redémarrer la transfusion. Par contre, il ne faut pas la poursuivre si une réaction hémolytique à la transfusion est soupçonnée.

Au cours d'une transfusion sanguine, surveillez souvent et attentivement l'animal pour détecter tout signe clinique évocateur d'une réaction.

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2. B) Le lavage bronchoalvéolaire révèle une inflammation neutrophilique et du mucus (spirales de Curschmann) chez les chevaux présentant une obstruction récurrente des voies respiratoires. Cette affection, communément appelée « souffle », fait partie du complexe de l'asthme équin.

L'obstruction récurrente des voies respiratoires est le principal diagnostic différentiel à envisager lorsque vous examinez un cheval âgé vivant au box, non fiévreux, qui tousse ou a une respiration sifflante et qui présente une fréquence respiratoire accrue au repos. Il s'agit d'une maladie inflammatoire chronique des voies respiratoires exacerbée par la poussière, le foin et la moisissure. Le diagnostic repose sur les signes cliniques et les résultats du lavage bronchoalvéolaire.

The ACVIM consensus statement on inflammatory airway disease nicely covers equine asthma.

Inflammatory airway disease (IAD) is the other disease in the equine asthma complex. Horses with heaves have increased respiratory rates at rest, whereas horses with IAD do not. Also, horses with IAD do not typically have abnormal lung sounds on auscultation. Both of these conditions can be characterized by chronic cough, exercise intolerance, and nasal discharge. Both can involve excessive airway secretions after exercise. Both can feature inflammatory cells identified in BAL samples. In general, horses with heaves tend to be older, whereas IAD is more common in performance horses of all ages.

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The questions and answers are provided by The Zuku Review, online veterinary test prep.

Les questions et les réponses sont gracieusement fournies par le site de préparation aux examens vétérinaires Zuku Review.

Le traitement vise principalement à réduire l'exposition à la poussière et au foin. L'animal devrait être gardé à l'extérieur si possible (à l'exception des cas moins fréquents d'obstruction récurrente des voies respiratoires associée aux pâturages), et recevoir des bronchodilatateurs (comme de l'albutérol ou du clenbutérol) et des corticostéroïdes. Le traitement peut être administré en injection, par voie orale ou par inhalation, ou une combinaison de tous ces éléments.

L'énoncé de consensus de l'ACVIM sur les maladies inflammatoires des voies respiratoires décrit bien le syndrome de l'asthme équin.

La maladie inflammatoire des voies respiratoires est l'autre maladie du complexe de l'asthme équin. Les chevaux atteints du souffle ont une fréquence respiratoire accrue au repos, ce qui n'est pas le cas des chevaux atteints de la maladie inflammatoire des voies respiratoires. De plus, ces derniers n'ont généralement pas de bruits pulmonaires anormaux lors de l'auscultation. Les deux affections peuvent être caractérisées par une toux chronique, une intolérance à l'exercice et un écoulement nasal. Elles peuvent se manifester par des sécrétions excessives des voies respiratoires après l'exercice. Dans les deux cas, il peut y avoir des cellules inflammatoires dans les échantillons obtenus par lavage bronchoalvéolaire. En général, les chevaux atteints du souffle ont tendance à être relativement âgés, alors que la maladie inflammatoire touche plus souvent les chevaux de performance de tous âges.

Référence

1. Smith BP, Van Metre DC, Pusterla N, eds. Large Animal Internal Medicine. 6th ed. North York, Ontario: Elsevier Canada, 2019:578-592.

Veterinary Dermatology
Dermatologie vétérinaire

Symmetric lupoid onychodystrophy (SLO)

Laura L. Quilling, Andrea T. H. Lam

Introduction

Although claw disease is an uncommon presenting complaint at veterinary hospitals, it is essential that clinicians are aware of diseases affecting the claws and claw folds, as these can greatly affect an animal's quality of life. "Onychodystrophy" refers to abnormal claw formation, including changes to shape, texture, and growth. However, the term "onychitis" may be considered more appropriate for this disease process, as symmetric lupoid onychodystrophy (SLO) is not a disease of primary claw malformation. Rather, changes to the claws are secondary to inflammation of the claw bed, leading to abnormal claw growth (1). This poorly understood disease is likely a reaction pattern that has a multifactorial pathogenesis including immune-mediated and hereditary components (1–3).

Clinical presentation

Symmetric lupoid onychodystrophy can affect dogs of any age but is most common in those between 2 and 6 y of age (2). The disease mainly affects, but is not limited to, large-breed dogs such as the German shepherd dog, Gordon setter, rottweiler, Labrador and golden retrievers, Akita, bearded collie, and boxer, among others (3–10). Affected dogs are often presented for evaluation of licking and chewing their paws, for acute lameness, or for suspected trauma causing claw avulsion. Physical exam can reveal a variety of findings, including onychomadesis (sloughing of the claws), onychorrhexis (splitting of the claws) (Figure 1), onycholysis (claw separation from the claw bed), and trachyonychia (roughened texture of the claws) (Figure 2). The presence of purulent discharge around the claw folds is suggestive of a secondary bacterial infection. Initially, only a single claw may be affected, but the disease will eventually progress to include multiple claws on multiple paws within weeks to months after initial presentation. Typically, upon regrowth, claws will have a misshapen or brittle appearance.

Animals with SLO generally do not display any signs of systemic disease, although follicular dysplasia and systemic lupus erythematosus (SLE) have been reported to occur in conjunction with SLO (7). Allergic dermatitis may also be present in some

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The Veterinary Dermatology column is a collaboration of *The Canadian Veterinary Journal* and the Canadian Academy of Veterinary Dermatology (CAVD). CAVD is a not-for-profit organization, with a mission to advance the science and practice of veterinary dermatology in Canada, in order to help animals suffering from skin and ear disease to live the lives they are meant to. CAVD invites everyone with a professional interest in dermatology to join (www.cavd.ca). Annual membership fee is $50. Student membership fees are generously paid by Royal Canin Canada.

Figure 1. Onychorrhexis: Splitting of the claw sheath in a golden doodle dog with symmetric lupoid onychodystrophy (SLO).

Photograph supplied by L. L. Quilling.

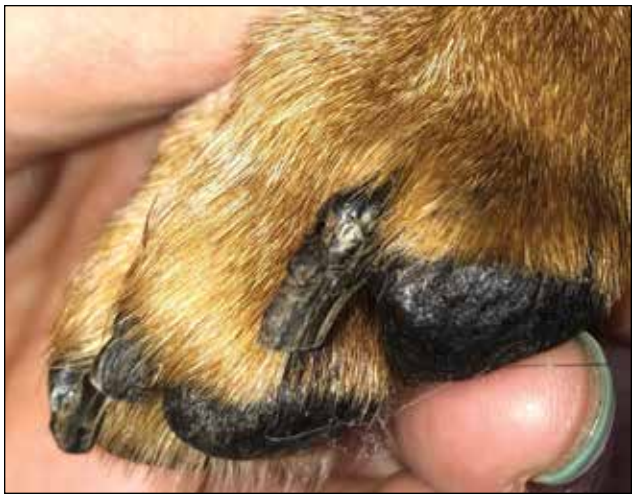

Figure 2. Trachyonychia: Roughened surface of the claw in a dachshund dog with symmetric lupoid onychodystrophy (SLO).

Photograph supplied by L. L. Quilling.

individuals; however, in the authors' opinion, this is unlikely to be a predisposing factor for SLO.

Pathogenesis

As there is an increased incidence of SLO in certain dog breeds, a hereditary component is suspected. Genes encoding dog leukocyte antigens (DLA) are responsible for regulation of numerous immune-mediated functions in dogs. In Gordon setters, giant schnauzers, and bearded collies, an increased risk of developing SLO was demonstrated in individuals with homozygosity for DLA Class II (3). Furthermore, the association with DLA Class II strongly supports an immune-mediated component to SLO (3). More recently, bearded collies were reported to have alterations to canine chromosomes (CFA) 12 and 17 (11). Conversely, 1 study failed to demonstrate SLO protein-encoding variants on CFA17 (12). Although the specific chromosomal alterations leading to SLO have not yet been established, CFA12 is a highly probable candidate gene.

Evaluation of thyroid function has been proposed for dogs affected with SLO. In a prior investigation, hypothyroidism was confirmed in 17% of dogs, which was more than the expected prevalence within the general canine population (13). However, an association between hypothyroidism and SLO is still unclear. It has been proposed that the affected cohort may have had a genetic predisposition to developing immune-mediated disease, or that antithyroid antibodies may become bound to claw matrix proteins (13).

In 1 review paper, 4 of 24 dogs with clinical signs of SLO achieved remission after completing an elimination diet trial (13). Two of these dogs were definitively proven to have a food allergy following a dietary provocation challenge. However, none of these dogs had additional clinical signs aside from claw disease (13).

Diagnosis

When investigating the cause of claw disease, cytology should always be done, as secondary bacterial and *Malassezia* paronychia, and onychomycosis are common. Other differential diagnoses include trauma, parasitosis, leishmaniosis, and immune-mediated diseases such as vasculitis, pemphigus foliaceus, pemphigus vulgaris, bullous pemphigoid, cutaneous drug reaction, and other diseases in the lupus category (2,13). It is important to emphasize that most of these diseases would not be limited to the claws alone, and concurrent dermatologic or systemic signs would also be observed.

A single study analyzing abnormalities in the laboratory findings of affected individuals indicated mild, variable changes on hematology and biochemistry that were not considered clinically relevant (13). Because changes are inconsistent, blood work is unlikely to offer additional clinical insight and would better serve as a general baseline health assessment prior to initiating treatment for SLO. Antinuclear antibody titers were negative in all dogs and are not warranted as part of the diagnostic workup (13). However, it may be worthwhile to consider an elimination diet trial to further investigate the role of food allergy.

Definitive diagnosis requires a biopsy of affected claws, which involves amputation of the third phalanx (P3) (2,4). This allows for examination of the entire structure as well as the claw matrix, which is not possible when avulsed or sloughed claws alone are submitted for histopathological evaluation (2). Amputation of an affected dew claw is always recommended, if available, to avoid surgical complications on weight-bearing digits. An alternative approach for biopsy of the lateral claw matrix has been described to avoid amputation (14); however, this method frequently yields nondiagnostic results and is now less commonly recommended. Histopathologic findings include interface inflammation composed of lymphocytes and macrophages, with fewer neutrophils and plasma cells at the junction of the claw bed epithelium and the dermis, with or without a lichenoid band (1). Because there are very few diseases that cause

claw abnormalities without concurrent dermatologic or systemic signs, many dermatologists make a presumptive diagnosis of SLO based on clinical findings and history alone, foregoing digit amputation altogether.

Management

One of the most common treatment options for SLO is doxycycline (or tetracycline) and niacinamide. This well-tolerated combination of an antibiotic and a B vitamin has immunomodulatory properties, although the exact mechanism is poorly understood. In 1 study, 22 of 30 dogs were treated with this combination therapy; there was an excellent response in 7 of those dogs and a partial response in another 7 dogs (6). It is worth mentioning that, despite its efficacy and safety, this combination therapy is starting to fall out of favor among dermatologists given the recent evidence highlighting the importance of practicing responsible antimicrobial stewardship.

Corticosteroids have potent anti-inflammatory to immunosuppressive activity. In 1 review in which prednisolone was used as a sole or multidrug therapy, a good to excellent response was reported in 4 of 5 dogs. However, treatment was suspended in 3 dogs due to adverse effects, and 1 dog died of acute pancreatitis (6). Although corticosteroid therapy appears to be highly efficacious, the authors recommended that it be reserved for refractory cases or short-term use only.

Oral essential fatty acids, particularly omega-3 and omega-6 fatty acids including γ-linoleic acid, may be helpful as adjunct or maintenance therapies (2,6,15). Several studies have shown variable responses, ranging from complete to partial to total lack of resolution, when used in combination with other treatments such as pentoxifylline and cyclosporine (5,6,16–18). One study comparing the efficacy of cyclosporine and essential fatty acid supplementation in dogs being fed a diet high in omega-3 fatty acids reported improvement of clinical signs in 13 of 14 dogs, and no statistically significant difference between treatment groups; however, neither treatment resulted in long-term cure (17). Monotherapy with essential fatty acids and pentoxifylline has also been shown to produce complete or partial resolution (5,6,10,19). Although no studies have evaluated the use of cyclosporine as monotherapy, the authors consider this to also be a reasonable option for managing SLO, as no single therapy (or combination of therapies) appears to be superior.

Prognosis

Response to treatment is usually slow. In healthy laboratory colony dogs, claws grew at a rate of 0.7 to 2.1 mm/wk (20); therefore, assessment of clinical response should not be rushed, and client expectations must be adjusted accordingly. As new claws may not be normal in appearance, the presence of well-anchored claws with no signs of inflammation at the level of the claw bed and no pain on palpation around the claw folds should be considered a satisfactory response to therapy. In the authors' experience, response to therapy is dependent on the individual and may require trying $>$ 1 treatment option before finding the best fit. Treatment failure is uncommon, and most dogs can achieve a good quality of life with long-term management.

Conclusion

When discussing claw disease with clients, it is important to emphasize that SLO typically requires lifelong maintenance therapy. Additionally, diagnostic tests, such as cytology to rule out infection or an elimination diet trial to investigate food allergies, are important for formulating an initial treatment plan. Although diagnostic tests are important, in most cases an underlying etiology is seldom uncovered. Treatment is generally safe and well-tolerated. Given the good response to mild immunomodulation, immunosuppressive therapy is rarely warranted. Many dogs are expected to achieve and maintain a good quality of life.

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Diagnostic Ophthalmology
Ophtalmologie diagnostique

Marina L. Leis, Lynne S. Sandmeyer

History and clinical signs

A 6-year-old spayed female domestic shorthair cross cat was examined by the ophthalmology service at the Western College of Veterinary Medicine (Saskatoon, Saskatchewan). This cat was presented because of a pink, vascularized mass on the surface of the left eye that had been present for a few weeks. The menace responses and palpebral, oculocephalic, direct, and consensual pupillary light reflexes were normal bilaterally. Schirmer tear test (Schirmer Tear Test Strips; Alcon Canada, Mississauga, Ontario) values were 6 and 7 mm/min in the right and left eyes, respectively. Intraocular pressures were estimated with a rebound tonometer (Tonovet; Tiolat, Helsinki, Finland) and were 22 and 20 mmHg in the right and left eyes, respectively. Fluorescein staining (Fluorets; Bausch & Lomb Canada, Markham, Ontario) of the corneas was negative bilaterally. Examination of the left eye using a transilluminator (Welch Allyn Finoff Transilluminator; Welch Allyn, Mississauga, Ontario) and handheld biomicroscope (Kowa SL-17 Portable Slit Lamp; Kowa, Tokyo, Japan) revealed conjunctival hyperemia and a dense, vascularized opacity covering ~1/2 of the lateral cornea, with scattered overlying white plaques. Following application of 0.5% tropicamide (Mydriacyl; Alcon Canada), examination of both eyes using a transilluminator (Welch Allyn Finoff Transilluminator; Welch Allyn) and handheld biomicroscope (Kowa SL-17 Portable Slit Lamp; Kowa) revealed no other abnormalities, and indirect ophthalmoscopic (Heine Omega 500; Heine Instruments Canada, Kitchener, Ontario) examination was within normal limits in both eyes. A photograph of the left eye at presentation is provided for your assessment (Figure 1).

Figure 1. Anterior segment photograph of the left eye of a 6-year-old domestic shorthair cross cat.

What are your clinical diagnoses, differential etiologic diagnoses, therapeutic plan, and prognosis?

Discussion

The ophthalmic diagnosis was feline eosinophilic keratoconjunctivitis of the left eye. This was confirmed following cytology of the superficial white plaques that revealed eosinophils with their distinctive pink granules, lymphocytes, and plasma cells. Although this clinical presentation was characteristic for the condition, other differential diagnoses inciting significant corneal vascularization to be considered are corneal foreign body, a corneal stromal abscess, or, rarely, neoplasia of the ocular surface.

Eosinophilic keratoconjunctivitis in cats is a sporadic, immune-mediated condition affecting the ocular surface and characterized by an inflamed and vascularized cornea with multifocal deposition of white to pink granular plaques (1). It can present either unilaterally or bilaterally and there has been no association shown between this condition and other feline eosinophilic diseases such as cutaneous eosinophilic granuloma complex. The average age of onset is approximately 5 y and there is no known breed predilection (2,3). Most cats will present with some degree of discomfort or blepharospasm regardless of whether concurrent corneal ulceration is present. The diagnosis is confirmed *via* a cytologic sample that can be collected from the affected area of the ocular surface (4). This is completed by instilling a drop of topical ophthalmic anesthetic, such as proparacaine, and using the back of a beaver blade, a Kimura spatula, or a cytobrush to collect the sample. Once the sample is applied to a slide, it can be stained with Diff-Quik or submitted to a diagnostic laboratory for interpretation, and evaluated for the presence of eosinophils and other inflammatory cells such as lymphocytes and plasma cells (5). In

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more chronic cases with extensive inflammatory cell proliferation, a biopsy can confirm the diagnosis *via* histopathology.

Therapy consists of systemic and/or local immunosuppressive therapy to control inflammation (1–3,6). Topical ophthalmic preparations, such as prednisolone acetate and dexamethasone, provide the most potent and targeted therapy while avoiding the systemic effects of oral and parenteral corticosteroids, such as megestrol acetate and triamcinolone, respectively. However, topical corticosteroids may be contraindicated in cases with concurrent corneal ulceration and may exacerbate coincident feline herpesvirus-1 (FHV-1) infection or promote recrudescence of latent virus. In about 1/3 of cases that present with concurrent corneal ulceration, initial topical immunomodulatory therapy with topical cyclosporine A or subcutaneous triamcinolone may be a safer alternative (2,6). Initiating a topical (*e.g.,* idoxuridine) or oral (*e.g.,* famciclovir) antiviral medication may be beneficial in reducing viral load, encouraging ulcers to heal, or preventing ulcers from forming as a result of FHV-1 recrudescence caused by topical immunosuppression.

Similar to therapy for other inflammatory diseases with an immune-mediated or idiopathic basis, therapy for feline eosinophilic keratoconjunctivitis is prolonged and medication tapering is indicated only following disease control (1). In eosinophilic keratoconjunctivitis, time to resolution of clinical signs once therapy was initiated was reported to take an average of 2 mo in 1 study, and recurrences were common (2). In the present case, the following medications were prescribed for the affected eye: topical prednisolone acetate 1% eye drops, q6h, to control inflammation; topical cyclosporine A 0.1%, q12h, for immunomodulation; and idoxuridine 0.1%, q6h, to help prevent FHV-1 reactivation. The cat was returned for re-evaluation 6 wk following initial presentation; at that time, the cornea had cleared substantially, so medications were reduced slowly. Six months later, this cat is still receiving topical cyclosporine A 0.1%, q12h, and has had no recurrences.

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Veterinary Practice Management
Gestion d'une pratique vétérinaire

Wage deflation hits veterinarians in government, industry, and academia

Déflation des salaires des médecins vétérinaires du gouvernement, de l'industrie et des milieux collégial et universitaire

Maisey Kent, Darren Osborne

Although wages for veterinarians in clinical practice continue to outpace inflation, the most recent report on veterinarians in government, industry, and academia shows a pronounced drop in wages across most non-practice sectors. Veterinary salaries in government, industry, and academia were not only below inflation for 2022, but dollar-for-dollar, they were also lower than in the previous year. This does not necessarily mean individuals took pay cuts — it could reflect a cluster of lower-salary veterinarians reporting. Whatever the source, this is the first sign of a softening in wages in the veterinary industry.

Each year, the Canadian Veterinary Medical Association partners with the Ontario Veterinary Medical Association, the Canadian Animal Health Institute, and the Canadian Association for Laboratory Animal Medicine to produce a report

Alors que les salaires des médecins vétérinaires en pratique clinique continuent de croître à un taux supérieur à l'inflation, le dernier rapport sur les salaires des médecins vétérinaires du gouvernement, de l'industrie et des milieux collégial et universitaire montre une baisse prononcée des salaires dans la plupart des secteurs autres que la pratique. Ainsi, en plus de ne pas avoir suivi l'inflation, les salaires des vétérinaires qui travaillent au gouvernement, dans l'industrie et dans les milieux collégial et universitaire en 2022 étaient inférieurs à ceux de l'année précédente. Cela ne signifie pas nécessairement que les vétérinaires ont subi des baisses de salaire – ce constat pourrait simplement refléter un nombre accru de répondants moins bien rémunérés. Quelle qu'en soit la source, c'est le premier signe d'un fléchissement des salaires dans l'industrie vétérinaire.

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Veuillez adresser toute correspondance à l'ACMV (admin@cvma-acmv.org).

Table 1./Tableau 1. Median annual salary ($) by veterinary sector in 2021 and 2022./Salaire annuel médian ($), par secteur, en 2021 et 2022.

	2022	2021	Change Variation
University/college Milieu collégial ou universitaire	141 000	150 000	−6%
Industry/pharmaceutical Industrie/société pharmaceutique	140 000	155 000	−10%
Laboratory animal medicine Médecine des animaux de laboratoire	124 000	130 000	−5%
Federal government Gouvernement fédéral	111 000	120 000	−8%
Provincial government Gouvernement provincial	120 500	116 000	4%

Table 2./Tableau 2. Median annual hours worked by veterinary sector in 2021 and 2022./Nombre médian d'heures travaillées par année, par secteur, en 2021 et 2022.

	2022	2021	Change Variation
University/college Milieu collégial ou universitaire	1870	1880	−1%
Industry/pharmaceutical Industrie/société pharmaceutique	1760	1820	−3%
Laboratory animal medicine Médecine des animaux de laboratoire	1650	1761	−6%
Federal government Gouvernement fédéral	1725	1725	0%
Provincial government Gouvernement provincial	1800	1725	4%

on compensation, hours worked, and benefits for veterinarians employed in government, industry, and academia. For the year 2023, the response was strong (368), with participation from all sectors.

Compared to the previous year, median compensation for veterinarians in government, industry, and academia fell an average of 6.2% in 2022. Of all sectors, provincial government was the only one that saw a year-over-year increase in median salary. In other sectors, the drop ranged from 10%, for DVMs in industry or pharmaceuticals; to 5%, for DVMs in laboratory animal medicine (Table 1).

The only sector that saw an increase in salaries (provincial government) also reported an identical increase in annual hours worked. Annual hours worked went down in other sectors, but the change was too low explain the drop in wages. Across all sectors, the median drop in annual hours worked was only 1.3% (Table 2).

Examining veterinarians in government, industry, and academia by educational qualifications shows those with MBAs and laboratory animal medicine certifications were the only groups to have salary increases above the rate of inflation (7%). Veterinarians with an MBA earned 33% more in 2022 compared to 2021, and veterinarians certified in laboratory animal medicine earned 30% more (Table 3).

Table 3./Tableau 3. Median annual veterinarian salary ($) by educational qualifications in 2021 and 2022./Salaire annuel médian des médecins vétérinaires ($) en fonction de leurs diplômes, en 2021 et 2022.

Educational qualifications Formation et diplômes	2022	2021	Change Variation
DVM D.M.V.	122 000	130 000	−6%
DVM and Cert LAM D.M.V. et certification en médecine des animaux de laboratoire	142 712	110 000	30%
DVM and DVSc and specialization D.M.V., D. V. Sc. et spécialisation	167 500	180 000	−7%
DVM and MBA D.M.V. et MBA	218 000	164 500	33%
DVM and MSc D.M.V. et M. Sc.	126 958	135 000	−6%
DVM and MSc and PhD D.M.V., M. Sc. et Ph. D.	165 000	160 000	3%
DVM and MSc and PhD and specialization D.M.V., M. Sc., Ph. D. et spécialisation	132 000	123 000	7%
DVM and MSc and specialization D.M.V., M. Sc. et spécialisation	145 500	140 670	3%
DVM and PhD D.M.V. et Ph. D.	141 845	160 000	−11%
DVM and PhD and specialization D.M.V., Ph. D. et spécialisation	121 000	132 530	−9%
DVM and specialization D.M.V. et spécialisation	143 766	153 000	−6%

Chaque année, l'Association canadienne des médecins vétérinaires s'associe à l'Ontario Veterinary Medical Association, à l'Institut canadien de la santé animale et à l'Association canadienne de la médecine des animaux de laboratoire pour produire un rapport sur la rémunération, les heures travaillées et les avantages sociaux des médecins vétérinaires employés par le gouvernement, l'industrie et les milieux collégial et universitaire. Pour l'année 2023, la participation a été élevée (368) avec des répondants de tous les secteurs.

Par rapport à l'année précédente, la rémunération médiane des médecins vétérinaires du gouvernement, de l'industrie et des milieux collégial et universitaire a diminué en moyenne de 6,2 % en 2022. Les vétérinaires à l'emploi du gouvernement provincial étaient les seuls à présenter une augmentation de leur salaire médian. Dans les autres secteurs, la baisse variait de 5 % pour les vétérinaires en médecine de laboratoire à 10 % pour ceux de l'industrie et du milieu pharmaceutique (tableau 1).

Les employés du seul secteur qui a connu une augmentation des salaires (gouvernement provincial) ont également signalé une augmentation proportionnelle du nombre d'heures travaillées par année. Le nombre annuel d'heures travaillées a diminué dans d'autres secteurs, mais cette baisse n'était pas assez marquée pour expliquer la baisse des salaires. Dans l'ensemble des secteurs, la diminution médiane du nombre d'heures travaillées par année n'était que de 1,3 % (tableau 2).

En examinant les résultats en fonction des diplômes, les médecins vétérinaires du gouvernement, de l'industrie et des

Table 4./Tableau 4. Median annual salary ($) for veterinary associates in practice and veterinarians in government, industry, or academia in 2021 and 2022./Salaire annuel médian ($) des vétérinaires salariés en pratique et des vétérinaires du gouvernement, de l'industrie ou des milieux collégial ou universitaire, en 2021 et 2022.

	2022	2021	Change Variation
Associate in practice Vétérinaires salariés en pratique	108 446	96 864	12%
Government/industry/academia, DVM only Vétérinaires du gouvernement, de l'industrie et des milieux collégial et universitaire (détenteurs d'un D.M.V. seulement)	122 000	130 000	−6%
Wage gap Écart salarial	13 554	33 136	−59%

Deflated salaries in government, industry, and academia may ease the pressure on the wages of associates in practice. To compare across industries, veterinarians in government, industry, and academia were only considered if they did not have any additional specializations, postdoctorate degrees, or certifications; their sole qualification was a DVM degree (Table 4).

Compared to associates in practice, veterinarians in government, industry, and academia earn more, but the gap is narrowing. The reduction in salaries for DVMs outside of practice reduced the difference in salaries by 59%. From 2021 to 2022, wages for veterinarians in government, industry, and academia fell by 6%. Over the same period, associates in private practice saw their wages go up 12%, shrinking the wage gap from $33 136 to $13 554 (Table 4). If this trend continues for just 1 more year, the 2 groups will have similar wages. ■

milieux collégial et universitaire titulaires d'une maîtrise en administration des affaires (MBA) ou d'une certification en médecine des animaux de laboratoire étaient les seuls groupes à présenter des augmentations de salaire supérieures au taux d'inflation (7 %). En effet, les médecins vétérinaires ayant un MBA ont gagné 33 % de plus en 2022 qu'en 2021, et ceux ayant une certification en médecine des animaux de laboratoire ont gagné 30 % de plus (tableau 3).

La déflation des salaires des vétérinaires du gouvernement, de l'industrie et des milieux collégial et universitaire pourrait atténuer la pression sur les salaires des vétérinaires salariés en pratique. Aux fins de la comparaison entre les secteurs, seules les réponses des médecins vétérinaires du gouvernement, de l'industrie et des milieux collégial et universitaire ayant seulement un D.M.V. et qui ne possédaient pas de spécialisation, de diplôme postdoctoral ou de certification supplémentaire ont été prises en compte (tableau 4).

Par rapport aux vétérinaires salariés en pratique, les vétérinaires du gouvernement, de l'industrie et des milieux collégial et universitaire gagnent plus, mais l'écart se réduit. La diminution des salaires des vétérinaires hors pratique a fait chuter cet écart de 59 %. De 2021 à 2022, le salaire des médecins vétérinaires du gouvernement, de l'industrie et des milieux collégial et universitaire a baissé de 6 %. Au cours de la même période, les vétérinaires salariés en pratique privée ont vu leur salaire augmenter de 12 %. L'écart salarial est ainsi passé de 33 136 $ à 13 554 $ (tableau 4). Si cette tendance se poursuit pendant encore un an, les deux groupes auront des salaires similaires. ■

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