

## Investigating the relationship between abomasal hairballs and perforating abomasal ulcers in unweaned beef calves

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### Abstract

This study investigated the relationship between abomasal hairballs (trichobezoars) and perforating abomasal ulcers in unweaned beef calves <4 mo of age. The calves enrolled in the study represented routine necropsy submissions to veterinary practitioners in western Canada and to the Western College of Veterinary Medicine. Regardless of the cause of death, each calf was examined for evidence of abomasal ulcers and hairballs.

Thirty-two practitioners and the Western College of Veterinary Medicine provided 166 cases for the study; 56 died of perforating ulcers (ulcer calves), and 110 died of causes unrelated to the abomasum (non-ulcer calves). The calves ranged in age from 1–90 d; 154 (92.8%) were <61 d of age. Overall, ulcer calves were 2.74 ( $P = 0.003$ ) times more likely to die with an abomasal hairball than were the nonulcer calves. However, stratifying the calves into 2 age groups, young (<31 d) and old (>30 d), yielded conflicting results. While the young ulcer calves were 3.81 ( $P = 0.003$ ) times more likely to have a hairball than were the young nonulcer calves, there was no statistically significant relationship ( $OR = 0.76$ ,  $P = 0.65$ ) between ulcers and hairballs in the older calves. The authors concluded that the relationship between hairballs and ulcers in the young calves was probably spurious, created by a Berkson's bias. It is unlikely that abomasal hairballs have a significant role in the development of fatal perforating ulcers in beef calves.

### Résumé

**Étude de la relation entre la présence de boules de poils et d'ulcère perforant dans l'abomasum chez les veaux non sevrés**

Cette étude porte sur la relation entre les boules de poils (aegagropile) et l'ulcère perforant de l'abomasum rencontrés chez les veaux non sevrés âgés de

moins de quatre mois. Les animaux, au nombre de 166, provenaient des cas soumis pour autopsie générale au «Western College of Veterinary Medicine» et à 32 vétérinaires praticiens de l'Ouest canadien. Indépendamment de la cause de la mort, chaque veau était examiné pour détecter la présence d'ulcère et de boules de poils. Cinquante-six animaux sont morts d'ulcère perforant et 100 animaux sont morts d'une cause non reliée à l'abomasum. Les veaux étaient âgés entre 1 et 90 jours; 92,8 % (154) avaient moins de 61 jours. Les veaux présentant un ulcère avaient 2,74 fois plus de possibilités ( $P = 0,003$ ) de mourir avec la présence de boules de poils dans l'abomasum comparativement aux veaux non ulcérés. Toutefois, en subdivisant les veaux en deux groupes d'âge, «jeune» (<31 jours) et «âgé» (>30 jours), les résultats portaient à contradiction. Les veaux du groupe «jeune» présentant un ulcère avaient 3,81 ( $P = 0,003$ ) fois plus de possibilités d'avoir une boule de poils que ceux non ulcérés du même groupe d'âge et il n'y avait pas de relation significative ( $OR = 0,76$ ,  $P = 0,65$ ) entre la présence d'ulcère et de boule de poils pour les animaux du groupe âgé. Les auteurs concluent que la relation entre l'ulcère et les boules de poils citée pour le groupe de jeune âge était probablement faussée par le biais de Berkson. Il est peu probable que la présence de boule de poils dans l'abomasum ait un rôle significatif dans l'apparition de l'ulcère perforant chez les veaux.

(Traduit par docteure Thérèse Lanthier)

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### Introduction

The etiology of perforating abomasal ulcers in unweaned beef calves has not been determined. However, various theories have been proposed, and in some cases, accepted as plausible explanations for abomasal ulcer formation. These theories generally fall into 1 of 4 categories: nutritional deficiencies, especially copper (1,2); microbiological agents (3,4); stress (5); and abrasive agents, such as, roughages, geosediments, and trichobezoars (6–8). In western Canada, many producers and veterinarians believe that abomasal hairballs encourage fatal ulcer formation.

The association between abomasal hairballs and perforations dates back to the 9th century, with the conditions of “acute tympanites” and “Elf-shot” or

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**Table 1. Percent (number) of calves that died either due to ulcer or from other causes (nonulcer) and had an abomasal hairball at the time of death. These data are stratified into young (<31 d) and old (>30 d)**

Age	Cause of death	
	Ulcer	Nonulcer
All calves	57.1 (32)	32.7 (36)
Young	57.7 (15)	20.1 (24)
Old	56.7 (17)	63.1 (12)

“Elf-shotten” being attributed to mischievous elves and witches shooting hairballs into the bellies of cattle (9). More recently, the projectile theory has given way to an abrasion theory, whereby hairballs are thought to have an abrasive action on the mucosal lining of the abomasum (7,10), initiating an ulcerogenic process that eventually culminates in a perforating ulcer.

Conceivably, the rhythmic peristaltic contractions of the abomasum in the presence of a trichobezoar could generate abrasive forces, disrupting the normal defensive barriers and allowing for autodigestion of the abomasal wall. This reasoning is partially supported by the perception that hairballs are frequently found in the abomasum of calves having died of a perforating ulcer. However, this perception may be false, having been influenced by both an exposure suspicion bias and a recall bias (11). That is, people performing necropsies may be more diligent in their search for abomasal hairballs in calves having died of a perforating ulcer than in calves having died of diseases unrelated to the abomasum. In addition, finding a hairball in a calf with a perforating ulcer may be a memorable event, while a similar finding in a calf having died of pneumonia or enteritis may be considered inconsequential.

The objective of our study was to determine whether an association exists between abomasal hairballs and perforating abomasal ulcers of unweaned beef calves. The method of study chosen to investigate this association was the proportional mortality study, which is essentially a modified case-control study.

## Material and methods

One hundred and fifteen veterinary practices located in Manitoba, Saskatchewan, and Alberta were contacted by mail in spring 1993 and requested to participate in our study. Participation involved recording data on necropsies involving beef calves <4 mo of age. Necropsy submissions to the Western College of Veterinary Medicine (WCVM) were also included.

A specially designed, necropsy data form accompanied the initial mailing. This form was divided into 2 sections. The 1st section recorded data on the calf's age, sex, breed, herd of origin, cause of death, and number of hairballs found in the abomasum. The 2nd section was a

diagram of an abomasum incised along the greater curvature and folded open to expose the mucosa. Practitioners were instructed to sketch the approximate size and location of the perforation onto this diagram.

The causes of death were grouped into 5 broad categories: perforating ulcer, enteritis, septic processes (navel ill, pneumonia, meningitis, etc.), acute deaths (intestinal accidents, trauma), and other, such as, congenital defects and nonulcer calves with no specific diagnosis.

The data were entered into Epi Info, an organizational database (USD Incorporated, Stone Mountain, Georgia), and later cross-tabulated and analyzed in Statistix (Analytical Software, St. Paul, Minnesota).

The mean age was calculated for each of the 5 disease categories and analyzed by one-way analysis of variance (ANOVA) for significant differences (12). If the ANOVA was significant, Scheffe's method of pairwise comparisons was used to compare the mean age of the ulcer group to each of the 4 nonulcer groups. The calves were also stratified into 2 age groups, young (<31 d of age) and old (>30 d of age). The younger calves were further stratified into 4 weekly age intervals. Chi-square tests for independence (13), utilizing  $2 \times 2$  tables, tested for associations between the cause of death (ulcer versus nonulcer) and the presence of hairballs. A Mantel-Haenszel test statistic generated stratum specific odds ratios (OR) and a summary OR, and checked for statistical interactions (14).

The range and average number of hairballs found in the ulcer and nonulcer calves was determined. A two-sample *t*-test analyzed for differences in the average number of hairballs between these 2 groups.

## Results

One hundred and sixty necropsy forms were received from 32 practitioners. Six submissions were omitted because the primary cause of death was classified as an abomasal rupture, generally considered a postmortem artifact. An additional 2 ulcer cases were omitted because of missing age data. This provided 152 submissions from practitioners to which were added 14 submissions from the WCVM: 5 perforating ulcers and 9 nonulcers. Pooling the 2 datasets provided 166 cases: 56 perforating ulcers and 110 nonulcers.

The age of the calves ranged from 1 to 90 d; 154 (92.8%) were <61 d of age. Within the 5 disease categories, the mean ages ranged from 15.5 d in the enteritis calves to 39.5 d in the fatal ulcer calves. There were significant ( $P < 0.05$ ) differences in the mean ages of the perforating ulcer calves and those dying of enteritis, septic processes, and other diseases; there were no significant differences ( $P \geq 0.05$ ) in the mean age of the calves dying of perforating ulcers versus acute deaths. The youngest calves dying of ulcers were 7 d of age, whereas the youngest nonulcer calves were <1 d of age.

Hairballs were found in calves as young as 3 d of age. The maximum number of hairballs found in calves with ulcers and nonulcers was 5 and 8, respectively. The ulcer calves averaged 1.9 hairballs, the nonulcer calves 1.7. The difference between these 2 averages was not significant ( $P = 0.64$ ).

Overall, 57.1% of the ulcer calves versus 32.7% of the nonulcer calves had abomasal hairballs (Table 1).

**Table 2. Percent (number) of ulcer and nonulcer calves having an abomasal hairball and the odds ratio of finding a hairball in an ulcer calf**

Age (d)	Ulcer <sup>a</sup>	Nonulcer <sup>b</sup>	Odds ratio (95% CI)	P value
All calves	57% (32)	33% (36)	2.74 (1.42–5.30)	0.003
Stratified by age groups (young and old)				
1–30	58% (15)	26% (24)	3.81 (1.55–9.36)	0.003
31+	57% (17)	63% (12)	0.76 (0.23–2.48)	0.65
First month divided into 4 weekly strata				
1–7	33% (1)	22% (7)	1.79 (0.14–22.70)	0.65
8–14	75% (3)	28% (8)	7.87 (0.71–86.92)	0.06
15–21	25% (1)	22% (4)	1.17 (0.09–14.51)	1.00
22–28	70% (7)	40% (4)	3.50 (0.55–22.03)	0.37

<sup>a</sup>Calves dying of a fatal abomasal ulcer

<sup>b</sup>Calves dying of diseases unrelated to the abomasum

However, only the young nonulcer calves had significantly fewer hairballs than did the other 3 groups. The overall odds of finding a hairball in an ulcer calf was 2.74 times ( $P = 0.003$ ) greater than finding a hairball in a nonulcer calf (Table 2). However, stratifying by the 2 age groups, young and old, provided markedly different ORs. Young ulcer calves were 3.81 times ( $P = 0.0028$ ) more likely to have a hairball than were the young nonulcer calves. In contrast, there was no statistically significant relationship ( $OR = 0.76$ ,  $P = 0.65$ ) between ulcers and hairballs in the older age group. Significant interaction ( $P = 0.02$ ) among strata precluded the use of a summary OR. Therefore, the data should be interpreted using the stratum specific ORs.

The majority (89%) of the perforations occurred in the body of the abomasum, with a propensity for the greater curvature.

## Discussion

Calves <1 mo of age and dying of an ulcer were almost 4 times more likely to have a hairball in their abomasum than were calves dying of all other causes. However, this association did not exist in the older calves (>30 d), with approximately 60% of all calves, regardless of the cause of death, having an abomasal hairball. Paradoxically, although the ORs for the 2 age groups were different, 3.81 versus 0.76, the prevalence of hairballs in the young (57.7%) and old (56.7%) ulcer calves, and old nonulcer (63.1%) calves was very similar. This was in sharp contrast to the prevalence of hairballs in the young nonulcer calves (20.1%). This leads one to question whether the cause of death in the young nonulcer calves interfered with normal hairball formation, a situation that is the very opposite to suggesting that hairballs cause ulcers. We assumed, at the start of the study, that the prevalence of hairballs in the control group (nonulcers) should represent the prevalence of hairballs in a healthy population of calves. However, if our assumption was invalid, then a spurious association may have arisen from the unforeseen relationship between the controls (nonulcer calves) and risk factor (hairballs).

This spurious association is referred to as Berkson's paradox or bias (15).

Two factors, time and cause of death, may have decreased the prevalence of hairballs in the young nonulcer calves, creating a Berkson's bias. Over half (55.5%) of the nonulcer calves died in the first 2 wk of life, compared with only 12.5% of the ulcer calves. As a result, calves in the ulcer group had more time in which to develop an abomasal hairball. Stratifying the data into weekly intervals should have controlled for this age effect; however, there were too few ulcer calves to provide a meaningful statistical analysis (Table 2). A second factor that may have influenced hairball formation was the cause of death in the young nonulcer group. The majority (68%) of the calves died of enteritis and septic processes. Both of these types of disease have a relatively long duration of clinical disease compared with fatal ulcers. These sick calves would undoubtedly be lethargic and anorexic, making them less likely to engage in normal nursing behavior that involves nuzzling and licking the udder and underbelly, behavior that may encourage the ingestion of hair. In addition, these depressed calves probably groomed themselves less frequently, and for shorter periods of time, further reducing the likelihood of ingesting hair.

Two other important points support our contention that hairballs are not a significant risk factor for fatal ulcer formation. First, only slightly more than half (57%) of the calves dying of a perforating ulcer had a hairball, indicating that hairballs are not a necessary component of ulceration and that other factors are involved. This observation was not unique to our study. Pathologists working at regional pathology laboratories in Alberta reported that only 25% of the 50 calves submitted with a perforating ulcer had an abomasal hairball (16). Secondly, the majority (89%) of the perforations developed in the body of the abomasum, a region of the abomasum that has a poorly developed musculature, and which is incapable of producing strong peristaltic contractions (17,18). It is highly unlikely that the weak frictional forces generated in this region could exert an abrasive action upon the mucosal surfaces.

While we cannot state unequivocally that hairballs are not related to ulcer formation, it is important to realize that they are not necessary for ulcer formation, and that other causes must exist. It now seems prudent that we deemphasize the role of hairballs in fatal ulcer formation and concentrate on elucidating the other factors involved.

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