Indications for and factors relating to outcome after rumenotomy or rumenostomy in cattle: 95 cases (1999–2011)

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Objective—To evaluate indications for and factors relating to outcome after rumenotomy or rumenostomy in cattle.

Design—Retrospective case series.

Animals—95 cattle that underwent rumenotomy or rumenostomy.

Procedures—Medical records for 95 cattle that underwent either rumenostomy or rumenotomy at 2 veterinary teaching hospitals in 1999 through 2011 were analyzed. Reasons for the procedures were noted. Long-term outcome was determined during telephone interviews with owners.

Results—42 (44%) bovids underwent rumenostomy and 53 (56%) bovids underwent rumenotomy. Among the 42 animals undergoing rumenostomy, 18 (43%) had rumen cannulas placed during elective procedures. Other indications for rumenostomy included ruminal tympany (bloat [n = 20]), esophageal obstruction (choke [1]), grain overload (1), and provision of access for administration of enteral nutrition (2). Indications for rumenotomy included traumatic reticuloperitonitis (n = 31), bloat (9), foreign body (6), choke (5), and other (2). Long-term follow-up data were available for 31 of 42 (74%) bovids that underwent rumenostomy. Of those 31 animals, 17 (55%) were still in the herd, 4 (13%) had been culled, and 10 (32%) had died or were euthanized. Long-term follow-up data were available for 38 of 53 (72%) bovids that underwent rumenotomy. Of those 38 animals, 13 (34%) were still in the herd, 14 (37%) had been culled, and 11 (29%) had died or been euthanized.

Conclusions and Clinical Relevance—Results indicated that rumenotomy and rumenostomy can be effective in treating or relieving complications secondary to forestomach disorders in cattle. Bovids undergoing rumen surgery had a favorable prognosis for survival and a fair prognosis for potential return to production. (*J Am Vet Med Assoc* 2015;247:659–664)

Surgery of the rumen is commonly performed in cattle to relieve a variety of conditions affecting the forestomachs. Rumenotomy and rumenostomy are most commonly performed to remove foreign bodies or to relieve ruminal tympany (bloat). The location of the rumen against the left abdominal wall provides a convenient portal to access the reticulum, the reticulo-omasal orifice, and rumen. Although rumen surgery is commonly performed by veterinarians, few studies[1–3] have focused on such procedures. In particular, there is a dearth of literature regarding long-term outcomes for cattle after rumen surgery.[3] In 1950, a retrospective study[3] of rumen surgery in cattle revealed a short-term success rate of 35 of 50 (70%) bovids, with 12 of the 50 (24%) animals dying within 1 month after the surgical procedure. Causes of death in those cases included sepsis (n = 2), postoperative debilitation (5), chronic gastritis (2), or dehiscence (3).

Rumenotomy involves opening and closing the rumen during the same surgical event. Indications for rumenotomy include traumatic reticuloperitonitis, esophageal obstruction, foreign body ingestion, and bloat. Rumenotomy allows a surgeon direct access to the rumen, allowing for removal of ingested foreign bodies, penetrating hardware, and foreign objects lodged in the distal portion of the esophagus.[3–13] Rumenostomy involves creation of a temporary (small opening allowed to heal closed over time) or permanent (insertion of a cannula to maintain opening) stoma between the rumen and the skin of the bovid.[8] Although temporary rumenostomies are most often performed as therapeutic procedures for cattle with chronic bloat, they have also been used to provide access for administration of enteral nutrition.[8,14,15]

Unlike temporary rumenostomies, placement of a permanent rumen cannula is performed on healthy bovids to obtain rumen fluid for transfaunation or for nutritional re-

search purposes. These procedures are performed with the intention of keeping the stoma open by means of an inert plastic cannula with removable plug.

Rumen surgery is considered a clean-contaminated procedure when performed under ideal conditions on healthy animals, as with elective rumen cannula placement. However, rumen surgery can vary from clean-contaminated to dirty fields. Examples of contaminated rumen surgeries include surgeries where there is abdominal contamination with ruminal contents. Dirty rumen surgeries include cases of traumatic reticuloperitonitis with extensive peritonitis. Degree of contamination should be evaluated for each individual patient.

The primary objectives of the study reported here were to evaluate indications for and outcomes (both short and long term) of rumenotomy and rumenostomy in cattle. We hypothesized that rumen surgery would be associated with favorable short-term survival rate and that long-term survival rate would be dependent on presence and severity of the underlying disease.

Materials and Methods

Case selection—Medical records for all cattle admitted to either Kansas State University Veterinary Medical Center or The Ohio State University Veterinary Medical Center from January 1, 1999, to December 31, 2011, were analyzed. Cattle that underwent rumenotomy or rumenostomy were included in the study. Animals that died or were euthanized during surgery or immediately after surgery (within 24 hours) were excluded from the study population.

Medical records review—Data retrieved included signalment (age, weight, sex, and breed), clinical problem, presence of concurrent disease, results of diagnostic tests, duration of hospitalization, surgical procedure and findings, postoperative drug treatment, complications, and short-term (within < 30 days after surgery) outcomes. Telephone interviews were conducted to determine long-term outcome (return to function) and owner satisfaction. Owners of animals discharged from the hospital were contacted by telephone and asked a standardized set of questions to assess perceived postoperative progress, presence or resolution of postoperative complications, return of animal to expected function, and overall owner satisfaction. Owner satisfaction was scored on a scale of 1 to 5, with 5 being extremely satisfied and 1 being extremely unsatisfied.

Results

Records for 95 cattle undergoing rumen surgery at The Ohio State University (n = 67) and Kansas State University (28) were analyzed. Of the 95 cattle, 42 (44%) underwent rumenostomy and 53 (56%) underwent rumenotomy. Among the 53 cattle that underwent rumenotomy, 5 were sexually intact males and 48 were females. Dairy breeds were the most commonly represented, constituting 35 of the 53 (66%) cattle that underwent rumenotomy; 18 of those 53 (34%) cattle were beef breeds. For the cattle that underwent rumenotomy, age at the time of hospital admission ranged from < 1 day to 11 years (mean, 3.8 years). Weights ranged from 32 to 818 kg (70.4 to 1,799.6 lb); mean weight was 518 kg (1,139.6 lb). The cattle that underwent rumenostomy were classified into elective (rumen cannula placement) and therapeutic subpopulations. Of the 24 cattle that underwent therapeutic rumenostomy, 12 were female, 8 were sexually intact males, and 4 were steers. Among these animals, 9 (38%) were dairy breeds and 15 (62%) were beef breeds; age at hospital admission ranged from 15 days to 11 years (mean, 1.8 years). Weights ranged from 39 to 773 kg (85.8 to 1,700.6 lb); mean weight was 509 kg (1,119.8 lb). Of the 18 cattle that underwent elective rumen cannula placement, 17 were females and 1 was a steer. Among these animals, 16 were dairy breeds and 2 were beef breeds; age at hospital admission ranged from 14 months to 4 years (mean, 2.4 years). Weights ranged from 318 to 675 kg (699.6 to 1,485.0 lb); mean weight was 475 kg (1,045.0 lb).

Indications for either surgery were variable. Among the 42 cattle that underwent rumenostomy, 24 had temporary rumenostomies for treatment of medical disorders. Of these 24 cattle, indications for rumenostomy included chronic bloat (n = 20), esophageal obstruction (1), and rumen acidosis caused by excessive grain ingestion (1) as well as provision of access for administration of enteral nutrition (2). The other 18 bovids had elective rumen cannulas placed for research purposes or access to transfaunation material.

Among the 53 cattle that underwent rumenotomy, indications for the procedure included traumatic reticuloperitonitis (n = 31), primary bloat (9), ruminal or reticular foreign body (6), esophageal obstruction (5), and diagnostic exploratory examination of the rumen (2). Objects were considered rumen foreign bodies if they were contained with the reticulorumen, caused a functional obstruction, and were not penetrating a ruminal or reticular wall. Traumatic reticuloperitonitis was diagnosed either before or during surgery. Of the 31 bovids that underwent rumenotomy for treatment of traumatic reticuloperitonitis, 19 (61%) received the diagnosis before surgery on the basis of presence of a metallic foreign body in the region of the reticulum on radiographic views. Although ultrasonography alone cannot be used to determine presence of a metallic foreign body,[16] it was either used solely to evaluate presence of peritonitis and strength of reticular contractions or used in addition to radiography to confirm the presumptive diagnosis of traumatic reticuloperitonitis. If traumatic reticuloperitonitis could not be confirmed prior to surgery, removal of a penetrating metallic foreign body during diagnostic rumenotomy was considered confirmation.

Perioperative protocols and surgical procedures varied at the discretion of the individual clinician. In cattle that underwent rumenotomy, 4 techniques were used, including rumen skin suturing fixation (n = 49 [93%]), rumen board rumenotomy (1), stay suture rumenotomy (2), or rumen skin clamp fixation (1). Surgical methods for these procedures have been described.[2,8] For the 42 cattle that underwent rumenostomy, all procedures were performed by means of the rumen skin suturing method. Most surgeries (91/95 [96%]) were performed with the animal standing in a chute. For neonatal cattle, rumen surgeries were performed with the patient in right semisternal recumben-

cy. No intraoperative complications were noted in the examined medical records.

Perioperative antimicrobial treatment was recorded for 52 of 53 (98%) cattle that underwent rumenotomy. The most common antimicrobial drugs administered included penicillin G procaine (22,000 U/kg [10,000 U/lb], IM, q 24 h; mean duration of treatment, 4.8 days; n = 24) and oxytetracycline (10 to 20 mg/kg [4.5 to 9.1 mg/lb], SC; mean duration of treatment, 3.6 days; 17). Use of florfenicol and ampicillin in 1 bovid each was reported. Anti-inflammatory drugs were administered in 35 of 53 (66%) cattle that underwent rumenotomy, and flunixin meglumine (1.1 mg/kg [0.5 mg/lb], IV, once daily; mean number of doses, 1.4; n = 34) was most commonly administered. Dexamethasone was used in 1 bovid.

Antimicrobial and anti-inflammatory drugs were administered less frequently in cattle that underwent rumenostomy. Of 24 cattle undergoing therapeutic rumenostomy, 22 (92%) received antimicrobials. The most commonly used drugs were penicillin G procaine (22,000 U/kg, IM, q 24 h; mean duration of treatment, 3.4 days; n = 10) and ceftiofur sodium (1.1 mg/kg, SC, once daily; mean duration of treatment, 2.3 days; 6). There were reports of the use of tulathromycin in 2 bovids, oxytetracycline in 2 bovids, enrofloxacin in 1 bovid, and florfenicol in 1 bovid. In the 18 cattle that underwent elective cannula placement, 14 received perioperative antimicrobial drugs. The most commonly administered drugs in this subpopulation were penicillin G procaine (22,000 U/kg, IM, q 24 h; mean duration of treatment, 1.4 days; n = 10) and oxytetracycline (20 mg/kg, SC, single dose; 4). Only 55% of bovids that underwent rumenostomy received anti-inflammatory drugs, with flunixin meglumine (1.1 mg/kg, IV, once daily; mean number of doses, 1.1 doses; n = 23) being the drug of choice in all cases.

Concurrent diseases were common among the cattle with the exception of healthy cattle that underwent elective rumen cannula placement. In cattle that underwent rumenotomy, reticular abscesses and vagal indigestion were the most commonly reported concurrent diseases (5/53 [9.4%] each; **Table 1**). Ten of 53 (19%) cattle in-

cluded in the study were reported to have > 1 concurrent disease at the time of hospital admission. In the 24 cattle that underwent therapeutic rumenostomy, 6 were reported to have > 1 concurrent disease at the time of hospital admission; pneumonia was the most commonly reported concurrent disease (5/24 [21%] cattle). Other concurrent diseases included lymphoma, abomasal impaction, patent urachus, and megaesophagus.

Data regarding short-term (within < 30 days after surgery) outcomes were available for all cattle that underwent rumenostomy or rumenotomy. Long-term follow-up information was obtained for 69 of 95 (73%) cattle. Short-term complications of both rumenotomy and rumenostomy included incisional problems and death or euthanasia in the initial 30-day postoperative period (**Table 2**). Incisions with purulent discharge were considered infected. Two bovids that underwent therapeutic rumenostomy died within 1 week after surgery, with one dying of an acute bloat episode and the other sent to slaughter. Three bovids that underwent rumenotomy were reported to have died or been euthanized as a result of peritonitis within 30 days after surgery.

Long-term follow-up information was available for 38 of 53 (72%) cattle that underwent rumenotomy. Long-term follow-up data for these animals were obtained 5 months to 5 years after initial evaluation (mean, 2.4 years). Of these 38 cattle, 13 (34%) were still in the herd, 14 (37%) had been removed from the herd, and 11 (29%) had died or been euthanized (**Table 3**). Most cattle that were removed from the herd were sold or culled because of poor performance; 8 bovids were removed because they failed to return to normal production, and 6 bovids were removed because of causes unrelated to surgery (including reproductive problems and old age). Causes of death and reasons for euthanasia included peritonitis (n = 4), unspecified cause (3), severe circumferential esophageal ulceration (1), lymphoma (1), abomasal ulcer (1), and septic arthritis (1).

Long-term follow-up information was available for 31 of 42 (74%) cattle that underwent rumenostomy. Long-term follow-up data for these animals were obtained 5 months to 6 years after initial evaluation (mean, 2.2 years). Of these 31 cattle, 13 had undergone elective cannula procedures and 18 had undergone temporary rumenostomy. Of the 13 bovids that underwent elective cannula placement, 12 were still in the herd and 1 was euthanized. The latter animal was reported to have had chronic laxity and subsequent infection around the cannula site and was euthanized because of failure to maintain body condition. Peritonitis was detected during its necropsy. Of the 18 bovids that underwent temporary rumenostomy for which long-term follow-up information was available, 5 were still in the herd, 4 had been removed from the herd, and 9 had died or were euthanized (Table 3). Removal of the 4 bovids from the herd was due to poor performance related to the initial disease process. Causes of death and reasons for euthanasia included unspecified cause (n = 3), lymphoma (1), complications of chronic pneumonia (1), abomasal volvulus (1), abomasal ulceration (1), bloat (1) and peritonitis (1).

Overall owner satisfaction with either procedure was favorable. For 38 cattle that underwent rumenotomy for which follow-up information was available, 30

Table 1—Concurrent diseases in 95 cattle that underwent rumenotomy or rumenostomy at either Kansas State University Veterinary Medical Center or The Ohio State University Veterinary Medical Center from January 1, 1999, to December 31, 2011.

Concurrent disease	Rumenotomy (n = 53)	Rumenostomy (n = 24)
Reticular abscess	5 (9)	0 (0)
Vagal indigestion	5 (9)	3 (13)
Pneumonia	4 (8)	5 (21)
Congestive heart failure	2 (4)	0 (0)
Hepatic lipidosis	2 (4)	0 (0)
Abomasal impaction	1 (2)	2 (8)
Pharyngitis or esophagitis	0 (0)	2 (8)
Lymphoma	1 (2)	1 (4)
Other concurrent diseases	7 (13)	5 (21)
> 1 concurrent disease	10 (19)	6 (25)

Data are reported as number (%) of bovids. Concurrent diseases were uncommon among the 18 healthy cattle that underwent elective rumen cannula placement; none of those 18 cattle had > 1 concurrent disease at the time of hospital admission.

Table 2—Number (%) of complications in the short-term postoperative period (< 30 days) for the 95 cattle in Table 1 that underwent rumenotomy or rumenostomy.

Complication	Rumenotomy (n = 53)	Rumenostomy (n = 42)	
		Therapeutic procedure (n = 24)	Elective placement of rumen cannula (n = 18)
Incisional infection	2 (4)	1 (4)	1 (6)
Seroma	2 (4)	0 (0)	0 (0)
Continuing regurgitation	1 (2)	NA	NA
Loose cannula	NA	NA	2 (11)
Death, euthanasia, or removal from herd	3 (6)	2 (8)	0 (0)

The cattle that underwent rumenostomy were classified into therapeutic and elective subgroups; 24 cattle underwent therapeutic rumenostomy, and 18 cattle underwent elective rumen cannula placement.
NA = Not applicable.

Table 3—Long-term follow-up information for 38 of 53 cattle that underwent rumenotomy and 31 of 42 cattle that underwent rumenostomy in Tables 1 and 2.

Initial clinical problem or reason for surgery	Rumenotomy (n = 38)			Rumenostomy (n = 31)		
	Still in herd	Removed from herd	Died or euthanized	Still in herd	Removed from herd	Died or euthanized
Traumatic reticuloperitonitis	6	9	8	—	—	—
Ruminal tympany (bloat)	2	2	1	5	4	8
Elective placement of rumen cannula	—	—	—	12	0	1
Foreign body	3	0	1	—	—	—
Esophageal obstruction (choke)	2	2	1	0	0	0
Grain overload	—	—	—	0	0	1
Other	0	1	0	—	—	—
Total	13	14	11	17	4	10

Data are reported as number of bovids. Long-term follow-up information for cattle that underwent rumenotomy was obtained 5 months to 5 years after initial evaluation (mean, 2.4 years). Long-term follow-up information for cattle that underwent rumenostomy was obtained 5 months to 6 years after initial evaluation (mean, 2.2 years).
— = Not applicable.

(79%) clients were satisfied with the outcome and 8 were unsatisfied (mean satisfaction score, 3.6 of 5). Follow-up information for 18 cattle that underwent therapeutic rumenostomy indicated that 13 clients were satisfied with the outcome and 6 were unsatisfied (mean satisfaction score, 3.4 of 5). Follow-up information for 13 cattle that underwent therapeutic rumenostomy indicated that 11 clients were satisfied with the outcome and 2 were unsatisfied (mean satisfaction score, 4.2 of 5).

Discussion

Results of the study reported here supported the hypothesis that rumenostomy or rumenotomy can be effective to relieve a variety of problems affecting the esophagus, reticulum, and rumen of cattle. These procedures were associated with few complications. Morbidity and death (or euthanasia) among bovids undergoing these procedures were most often associated with complications related to the initial disease process or other causes unrelated to the surgery. Overall, clients were satisfied with the outcome of the surgical procedures.

Both rumenotomy and rumenostomy are common procedures in bovine specialty practice; however, there is a scarcity of literature regarding indications for and outcomes of these procedures. To the authors' knowledge, only a small number of reports[3,7,9,14,15,17–20] detail and evaluate clinical outcomes for rumenotomy

and rumenostomy in cattle. A handful of other studies and case reports discuss various indications for rumenotomy or rumenostomy,[4,6,11,21–23] describe surgical techniques,[24,25] compare surgical methods,[2] and discuss prophylactic antimicrobial use.[1]

In cattle, the decision to pursue rumenotomy or rumenostomy is determined not only by the disease process necessitating the surgical procedure, but also by the intended purpose and value of the affected animal. In terms of purpose, rumenotomy and rumenostomy range from curative to salvage procedures, in large part because of the wide variety of indications for these interventions. Rumenotomy provides a temporary window into the bovine forestomachs, and results of the present study indicated that rumenotomy was most often performed either as a curative or diagnostic procedure, most commonly for cattle with traumatic reticuloperitonitis followed by those that required diagnostic assessment. Common indications for rumenotomy other than traumatic reticuloperitonitis include chronic bloat and foreign body removal. Rumenostomy, on the other hand, provides an alternative to eructation for gas release by creating a stoma between the rumen and the body wall, allowing chronically bloated cattle to achieve relief without serial oro- or nasogastric intubation. Unlike rumenotomy, rumenostomy is performed most often as a salvage procedure or to provide relief until the underlying disease process resolves. Chronic free gas bloat, or vagus indigestion syndrome, develops secondary to

various causes ranging from pharyngeal trauma to bronchopneumonia.[26] Rumenostomy is also a useful technique with which to provide access for administration of enteral nutrition to ruminants that would be unable to eat otherwise.[14,15] Elective rumenostomy is commonly performed as an elective procedure in healthy cattle for implantation of rumen cannulas. These cattle are used in both experimental and clinical settings.[27–29] Cattle undergoing elective rumen cannula procedures are selected in part because of their lack of comorbidities and are expected to have decreased major complication rates, compared with cattle undergoing therapeutic rumen surgery.

In the present study, dairy cattle were slightly overrepresented; however, this is consistent with variability in the case populations of the 2 hospitals. The distribution of breed types was compared with the general hospital populations, and no type was found to be overrepresented. Most cattle were female, which most likely reflected the greater perceived value of cows over male bovids as well as the overrepresentation of dairy cattle in the study.

Although several postoperative complications of rumen surgery were reported in the medical records, they were considered minor. The most common complications were associated with the skin incision and likely were associated with contamination encountered during this type of contaminated to dirty surgical procedure.[1,2,8,13] The primary clinical signs following rumenotomy were swelling, seroma, and subcutaneous emphysema at the incision site. Given the presence of the rumen cannula in the bovids that underwent elective rumenostomy, it is possible that incisional complications were underreported for this subpopulation. Overall, the apparent complication rate associated with rumen surgery was consistent with previously reported data, and complications did not appear to compromise patient recovery. It appears that the prognosis and outcome largely depend on the reason for evaluation and preoperative condition of the bovid and not operative factors.

Peritonitis is thought to be a major complication associated with rumen surgery.[8] Abdominal contamination with rumen contents will likely lead to development of peritonitis. The severity of peritonitis is dependent on the extent of contamination, antimicrobial administration, and the health status of the bovid.[18] Assessment of peritonitis as a postoperative complication is difficult because many cattle undergoing surgery of the rumen, particularly those with traumatic reticuloperitonitis, have evidence of peritonitis at time of surgery.[7,17,18,30] Ultrasonographic examination findings obtained prior to surgery are useful not only for diagnosis of reticuloperitonitis, but also for subsequent comparison to postoperative ultrasonographic examination findings. Serial ultrasonographic examinations may help to both monitor progression of peritonitis present prior to surgery, as well as identify peritonitis that develops secondary to surgery.[16,17,31–33] The type of rumenotomy performed has also been associated with risk of development of peritonitis. Cattle undergoing stay suture rumenotomy develop adhesions and abscesses more often than bovids undergoing rumen skin suturing fixation or rumen skin clamp fixation.[2] Postoperative peritonitis directly related to the surgical procedure could not be accurately evaluated owing to the retrospective nature of this study. Most rumenotomies in the present study were performed with the rumen skin suturing fixation technique, which has been associated with low complication rates in otherwise healthy animals.[2]

Perioperative administration of antimicrobial drugs decreases the rate of infections after rumen surgery.[1] Haven et al[1] reported that prophylactic use of penicillin in cattle significantly decreased the incidence of abscess formation following rumenotomy. Results of the present study also indicated that a dose of an antimicrobial administered at the time of surgery was as effective at reducing incidence of abscesses and postoperative infections as treatment with penicillin for 7 days of after surgery.[1] However, bovids in that previous nutrition study[1] were healthy Angus steers undergoing exploratory rumenotomy and were free of comorbidities. With the exception of animals that underwent elective placement of rumen cannulas, the cattle in the present study received longer courses of antimicrobial drugs to treat either the primary condition (eg, traumatic reticuloperitonitis) or concurrent diseases (eg, pneumonia in animals with chronic bloat caused by vagal indigestion syndrome).

Long-term results of the present study were similar to those reported for a previous study.[1] Although a large number of cattle undergoing these procedures were culled from the herd, died, or were euthanized during the follow-up period, client satisfaction was generally high. Among the cattle for which long-term follow-up data were available, 13 of 38 (34%) bovids that underwent rumenotomy and 5 of 18 (28%) bovids that underwent therapeutic rumenostomy were still in the herd. Of the 13 animals that underwent elective placement of a rumen cannula for which long-term follow-up data were available, 12 (92%) remained in the herd. For 21 bovids that died or were euthanized, causes of death or reasons for euthanasia in the postoperative period varied from diffuse peritonitis to leukosis. Animals that died secondary to peritonitis had peritonitis that either related to the reason for initial evaluation or related to a perforating abomasal ulcer. Owing to the retrospective nature of the present study and the variability in the interval between surgery and collection of long-term follow-up information, median survival time following each type of surgical procedure could not be accurately determined.

Results of the study reported here indicated that rumenotomy and rumenostomy are readily performed procedures that can be effective in treating disorders of the forestomachs or their secondary complications in cattle. Following either surgical procedure, retention of a treated animal within the herd was based primarily on its ability to return to its intended function. Postoperative complications specifically related to the surgical procedures were rare; however, death or loss of function commonly occurred as a consequence of the disease process. Clients seemed satisfied with the results of the surgical procedures. Overall, findings indicated that cattle undergoing surgery of the rumen appear to have a favorable prognosis for survival and potential return to production.

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From this month's *AJVR*

Effect of ascorbic acid on storage of Greyhound erythrocytes

Jorge A. Fontes et al

Objective—To assess changes in biochemical and biophysical properties of canine RBCs during cold (1° to 6°C) storage in a licensed RBC additive solution (the RBC preservation solution designated AS-1) supplemented with ascorbic acid.

Sample—Blood samples from 7 neutered male Greyhounds; all dogs had negative results when tested for dog erythrocyte antigen 1.1.

Procedures—Blood was collected into citrate-phosphate-dextrose and stored in AS-1. Stored RBCs were supplemented with 7.1mM ascorbic acid or with saline (0.9% NaCl) solution (control samples). Several biochemical and biophysical properties of RBCs were measured, including percentage hemolysis, oxygen-hemoglobin equilibrium, and the kinetic rate constants for O_2 dissociation, carbon monoxide association, and nitric oxide dioxygenation.

Results—Greyhound RBCs stored in AS-1 supplemented with ascorbic acid did not have significantly decreased hemolysis, compared with results for the control samples, during the storage period.

Conclusions and Clinical Relevance—In this study, ascorbic acid did not reduce hemolysis during storage. Several changes in stored canine RBCs were identified as part of the hypothermic storage lesion. (*Am J Vet Res* 2015;76:789–800)

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