Colonic Obstruction in Three Captive Reticulated Giraffe (*Giraffa camelopardalis reticulata*)


Published By: American Association of Zoo Veterinarians

DOI: [http://dx.doi.org/10.1638/2008-0102.1](http://dx.doi.org/10.1638/2008-0102.1)

COLONIC OBSTRUCTION IN THREE CAPTIVE RETICULATED GIRAFFE (GIRAFFA CAMELOPARDALIS RETICULATA)


Abstract: Fatal colonic obstructions were diagnosed in three captive, adult, reticulated giraffe (Giraffa camelopardalis reticulata). Clinical presentations varied, but all cases displayed decreased activity, anorexia, and considerably decreased fecal production, consistent with intestinal obstruction. Case 1 was diagnosed at necropsy with a phytobezoar obstructing the spiral colon. Case 2 was diagnosed at necropsy with a fecal impaction of the colon. Case 3 was diagnosed during surgery with colonic ileus. Cases 2 and 3 underwent surgical intervention but were markedly compromised by the time of surgery and died during surgery or 24 hr postoperatively. Gastrointestinal obstruction, requiring aggressive supportive care and early surgical intervention, should be considered in giraffe in which anorexia and substantially decreased fecal production are observed. Abdominal exploratory surgery will likely be necessary for diagnosis and treatment. Based on a small number of cases, gastrointestinal obstruction has a poor prognosis in giraffe.

Key words: Reticulated giraffe, Giraffa camelopardalis reticulata, intestinal obstruction, phytobezoar, fecal impaction, ileus.

INTRODUCTION

Gastrointestinal obstructions have been infrequently reported in giraffe. A survey of causes of mortality in captive giraffe held at American Zoo and Aquarium Association (AZA)-accredited facilities in the United States from 1988-2005 identified three cases of gastrointestinal obstructions (Long, pers. comm.).

In domestic ruminants, gastrointestinal obstructions are also uncommon and are classified into three categories. The first and most common category is physical obstruction of the intestinal lumen with infarction of the affected segment, and includes volvulus, intussusception, and strangulation.

This report describes two cases of lumenal colonic obstruction and one case of colonic functional ileus in captive, adult, reticulated giraffe (Giraffa camelopardalis reticulata) from three zoological institutions in North America.

CASE REPORTS

Case 1

A 5-yr-old female, 830-kg reticulated giraffe housed at the Chicago Zoological Society, Brookfield Zoo (Brookfield, Illinois, USA) presented for acute onset of decreased activity and partial anorexia. The giraffe was alert and responsive on initial visual exam. Presenting clinical signs persisted, and the giraffe was manually restrained in a chute for phlebotomy for hematologic and serum biochemical evaluation 24 hr after the onset of clinical signs. Complete blood count (CBC) and serum chemistry panel abnormalities included mild hemococoncentration (hematocrit 41.4%; reference range 33.9–46.6%; hemoglobin 14.3 g/dl; reference range 11.7–1.8 g/dl), mild hyperalbuminemia (3.87 g/dl; reference range 3.1–0.5 g/dl), moderate hyperchloremia (118 mEq/L; reference range 105–6 mEq/L), and mild hypophosphatemia (6.4 mg/dl; reference range 9.5 ± 2.6 g/dl).21 Feces were...
loose and contained undigested feed material. A sample submitted for fecal floatation and bacterial culture was negative for intestinal parasites and *Salmonella* spp.

Over the next 5 days, the giraffe remained less active than normal, with limited food and water consumption, and developed slight abdominal distension. Feces ranged from soft to normal in consistency, and fecal production decreased substantially by the fourth day after presentation. Results of a repeat CBC 4 days after presentation were similar to the initial CBC results. Serum chemistry abnormalities included an elevated creatinine (2.47 mg/dl; reference range 1.8 ± 0.4 mg/dl), hypocalcemia (7.83 mg/dl; reference range 9.9 ± 1.8 mg/dl), and a slightly elevated alanine aminotransferase ([ALT] 25 IU/L; reference range 13–11 IU/L). Protein electrophoresis results demonstrated a low albumin globulin ratio (0.39) secondary to hypoalbuminemia (2.59 g/dl) and mild polyclonal gammopathy (2.74 g/dl), compared with reference ranges for other ruminant species submitted to the reference laboratory (University of Miami, Miami, Florida 33124, USA). Results of a urinalysis and a urine protein creatinine ratio were unremarkable.

The giraffe was treated with flunixin meglumine (Flunixamine, Fort Dodge Animal Health, Fort Dodge, Iowa 50501, USA; 500 mg [days 3 and 4] or 750 mg [day 6] i.m.) by projectile dart or hand syringe. Six days after presentation, the giraffe was administered haloperidol (Haldol, OMP Division, Ortho-McNeil Pharmaceutical, Inc., Raritan, New Jersey 08869, USA; 15 mg i.m.) by projectile dart for sedation in preparation for supportive care and further evaluation. Within 20 min, the giraffe collapsed and went into cardiac arrest before resuscitative efforts could be initiated.

At necropsy, the lumen of the spiral colon, approximately 90 cm aborad to the cecum, was focal and completely occluded by a 5-cm-long × 3.2-cm-diameter cylindrical phytobezoar that was circumferentially tightly adhered to the colonic mucosa. The spiral colon aborad to the phytobezoar, and the descending colon were empty. The spiral colon orad to the phytobezoar was moderately distended with pasty and fibrous digesta. The ascending colon was markedly distended, and the cecum was impacted with large amounts of firm, dry, fibrous digesta. The mucosa of the tail of the cecum was hemorrhagic. The ileum, jejunum, and distal duodenum were markedly dilated and thin-walled, and they contained large amounts of fetid, turbid, watery, light brown fluid. The jejunal and ileal mucosa were diffusely hyperemic with multifocal petechiae, and the distal jejunal mucosa contained multiple ulcerations covered by fibrinonecrotic membranes. The rumen, reticulum, and abomasum contained large volumes of watery ingesta, and the pyloric abomasum had a focal 2-cm × 1-cm mucosal ulcer. Samples of the jejunum were obtained and submitted for aerobic and anaerobic culture. Representative samples of all organs were fixed in 10% neutral buffered formalin, processed routinely for histology, sectioned at 5 μm, and stained with hematoxylin and eosin. Selected sections were also prepared with the Brown and Hopps stain.

Histologically, at the site of the spiral colon phytobezoar, there was regional, subacute, ulcerative and hemorrhagic colitis with intralesional Gram-positive and Gram-negative bacilli. Severe, multifocal, jejunal mural congestion and hemorrhage and moderate, multifocal, fibrinopurpurative enteritis and sepsis with intralesional Gram-negative and Gram-positive bacilli were present. The pyloric abomasal ulcer was subacute. Moderate, multicentric congestion, consistent with cardiovascular collapse, was also noted. Additional histologic lesions included moderate, multifocal, endocardial hemorrhage; mild, multifocal, hepatocellular and renal proximal tubular hydropic degeneration; mild, mesenteric lymph node edema, histiocytes and multifocal erythrophagocytosis; and retained esophageal mucosal layers indicative of hyporexia. Aerobic and anaerobic cultures of the jejunum yielded isolation of *Salmonella Mbandaka*, *Clostridium perfringens*, *Clostridium ramosum*, and *Clostridium histolyticum* (probable identification).

**Case 2**

A 13-yr-old female, 815-kg reticulated giraffe housed at the Riverbanks Zoo and Garden (Columbia, South Carolina, USA) was immobilized for examination after 5 days of decreased food consumption and 2 days of anorexia, lack of fecal production, and lethargy. The giraffe was immobilized with medetomidine hydrochloride (ZooPharm, Laramie, Wyoming 82070, USA; 40 mg i.m. and 3 mg i.v. [cumulative]) and ketamine hydrochloride (ZooPharm; 450 mg i.m. and 550 mg i.v. [cumulative]), and anesthesia was reversed with atipamezole hydrochloride (Antisedan, Pfizer Animal Health, New York, New York 10017, USA; 70 mg i.m. [cumulative]). Physical exam findings included a thin body condition, dehydration (estimated 5–10%), and tachypnea. The CBC showed a marked leukocytosis (39,400/μl; reference range 12,740 ± 4,997/μl), with a marked mature neutrophilia (35,070/μl; reference range 9,207 ± 4,434/μl) and monocytosis (1,576/μl; reference range 395 ± 371/μl). Serum biochemical abnormalities included
hyperglycemia (309 mg/dl; reference range 135 ± 61 mg/dl), mildly elevated ALT (36 IU/L), mild hyponatremia (138 mEq/L; reference range 145 ± 4 mEq/L), hypochloremia (93 mEq/L), and hypocalcemia (7.3 mg/dl).\(^{21}\) Serum samples were submitted to several reference laboratories for serology for the following infectious diseases: *Leptospira bratislava*, *L. canicola*, *L. grippotyphosa*, *L. hardjo*, *L. icterohemorragica*, *L. pomona*, infectious bovine rhinotracheitis, bovine viral diarrhea, bovine respiratory syncytial virus, parainfluenza-3, and bovine tuberculosis. The giraffe was treated with crystalloid replacement fluids (Lactated Ringer’s Injection [LRS], B. Braun Medical Inc., Irvine, California 92614, USA; 13 L i.v.), amikacin sulfate (Amifuse E, Butler Animal Health Supply, Dublin, Ohio 43017, USA; 12 g i.v.), potassium penicillin (Amifuse, Pfizer Animal Health; 10 mg i.m.), and an anti-inflammatory (flunixin meglumine, 500 mg i.m. s.i.d.) via projectile dart. Anorexia and lack of fecal production persisted. Three days after the initial immobilization the giraffe was markedly dehydrated and had not urinated for 36 hr. Standing sedation was achieved using detomidine hydrochloride (Dormosedan, Pfizer Animal Health; 10 mg i.m.) and butorphanol tartrate (Torbugesic, Fort Dodge Animal Health; 50 mg i.m.) and supplemented with additional detomidine (20 mg i.m. [cumulative]) and antibiotics (cefotiofur sodium, Naxcel, Mckesson Animal Health; 12 g i.v.).

Over the next 2 days, the giraffe was treated supportively with antibiotics (cefotiofur sodium, Naxcel, Pharmacia and Upjohn Company, Division of Pfizer, Inc., New York, New York 10017, USA; 1 g i.m. s.i.d.) and an anti-inflammatory (flunixin meglumine, 500 mg i.m. s.i.d.) via projectile dart. Anorexia and lack of fecal production persisted. Three days after the initial immobilization the giraffe was markedly dehydrated and had not urinated for 36 hr. Standing sedation was achieved using detomidine hydrochloride (Dormosedan, Pfizer Animal Health; 10 mg i.m.) and butorphanol tartrate (Torbugesic, Fort Dodge Animal Health; 50 mg i.m.) and supplemented with additional detomidine (20 mg i.m. [cumulative]). Intravenous fluids (LRS, 13 L i.v. and 0.9% NaCl [B. Braun Medical Inc.; 2 L i.v.], electrolyte and mineral supplements (Cal-MPK 1080, Ivx Animal Health, Inc., St. Joseph, Missouri 64503, USA; 750 ml i.v.), antibiotics (cefotiofur sodium, 1 g i.v.; amikacin, 12.5 g i.v.) and an anti-inflammatory (flunixin meglumine, 500 mg i.v.) were administered over a 2-hr period. Toward the end of the fluid administration, the giraffe developed marked ventral cervical and intermandibular edema and dyspnea. It was treated with corticosteroids (prednisolone sodium succinate, Solu-Delta-Cortef, Pharmacia and Upjohn; 500 mg i.v.) and diuretics (furosemide, Disal Injection, Boehringer Ingelhemi Vet Medica, Inc., St. Joseph, Missouri 64506, USA; 500 mg i.m. and i.v.). The giraffe recovered from sedation without reversal. Edema resolved within 48 hr, and the giraffe urinated multiple times. Results of a CBC were within reference range for the species.\(^{21}\) Serum biochemistry panel demonstrated multiple times. Results of a CBC were within reference range for the species.\(^{21}\) Serum biochemistry panel showed marked azotemia (blood urea nitrogen [BUN] 71 mg/dl; reference range 20 ± 7 mg/dl; creatinine 6.3 mg/dl), marked hyperphosphatemia (19.9 mg/dl), hypocalcemia (6.3 mg/dl), elevated AST (882 IU/L), ALT (77 IU/L), GGT (454 IU/L), and lactate dehydrogenase ([LDH] 2,003 IU/L; reference range 869 ± 658 IU/L), and marked hyperbilirubinemia (total bilirubin 10.3 mg/dl; direct bilirubin 8.5 mg/dl).\(^{21}\) The following day, 6 days after the initial immobilization, the giraffe voluntarily entered a squeeze chute for supportive care. Chemistry panel results demonstrated progressive and severe hyperphosphatemia (28.7 mg/dl), marked azotemia (BUN 74 mg/dl; creatinine 5.5 mg/dl), hypocalcemia (5.1 mg/dl), hypoponatremia (140 mEq/L), hypokalemia (3.0 mEq/L; reference range 4.8 ± 0.6 mEq/L), hypochloremia (96 mEq/L), elevated creatine phosphokinase ([CPK] 34,027 IU/L; reference range 1,328 ± 1,654 IU/L), and persistently elevated AST (837 IU/L), ALT (84 IU/L), GGT (380 IU/L), LDH (2,521 IU/L), and
bilibilirubin (total bilirubin 10.1 mg/dl; direct bilirubin 8.5 mg/dl).21 After 1.5 hr in the squeeze chute, the giraffe had two seizures and became recumbent in the chute and unable to stand. It was sedated with detomidine (50 mg i.v.) and humanely euthanized with pentobarbital sodium and phenytoin sodium (Euthasol, Virbac Animal Health, Inc., Fort Worth, Texas 76161, USA; 150 ml i.v.).

At necropsy, the lumen of the colon, immediately orad to the spiral colon, was obstructed with firm feces. The colonic mucosal surface was circumferentially ulcerated at the location of the obstruction. Orad to the obstruction, the colon was severely dilated. Feces and colonic mucosal surfaces within the dilated colon were hemorrhagic. Portions of the jejunum were also hemorrhagic. The mucosal surfaces of the abomasum and omasum were multifocally ulcerated. The serosal surfaces of all portions of the gastrointestinal tract were covered with patchy accumulations of fibrin. The liver was swollen, and the kidneys were dark red. The lungs exuded clear foam on cut surface and appeared mildly congested. Representative samples of organs were collected and processed for histology as described for Case 1.

Histologically, severe, focal, necroplurulent colitis was observed. Other gastrointestinal lesions observed grossly were not evaluated histologically. Multifocal necrosis was present in the liver and contained moderate infiltrates of degenerated neutrophils. The hepatic necrosis was interpreted as secondary to disruption of the mucosal barriers in the intestine with subsequent sepsis and/or endotoxemia, although no organisms were identified on histology. Significant histologic lesions were not observed in remaining tissues. Results of infectious disease serology of serum samples obtained at initial immobilization were all negative.

Case 3
A 2-yr-old male, 900-kg reticulated giraffe housed at the Indianapolis Zoo (Indianapolis, Indiana, USA) presented acutely with clinical signs consistent with abdominal discomfort. Zoo keepers reported the giraffe had been lethargic the previous evening, and no feces or urine had been produced overnight. The giraffe was observed in lateral recumbency on exhibit early in the morning. The animal stood in response to zoo keepers and walked into an indoor holding facility. Standing sedation was attempted with detomidine hydrochloride (20 mg i.m. [cumulative]) and butorphanol tartrate (70 mg i.m. [cumulative]) but only resulted in mild sedation not sufficient for handling. Over the next 4 hr, the giraffe was observed intermittently lying down, and stretching, straining, and posturing to urinate or defecate without any output.

Four to 5 hr after presentation, the giraffe was immobilized with medetomidine hydrochloride (45 mg i.m. [cumulative]) and ketamine hydrochloride (500 mg i.m. [cumulative]) and supplemented with ketamine hydrochloride (600 mg i.v. [cumulative]) and butorphanol tartrate (10 mg i.v.). It was intubated with a 16-mm endotracheal tube and supplemented with isoflurane in oxygen (AErrane, Baxter Healthcare Corp., Deerfield, Illinois 60015, USA; 3%). Rectal palpation revealed the absence of feces and a nondistended urinary bladder. Results of a CBC and chemistry panel showed hyperglycemia (387 mg/dl), mild hyponatremia (138 mEq/L), hypokalemia (3.8 mEq/L), hypochloremia (98 mEq/L), and hypophosphatemia (4.4 mg/dl).21 An abdominal exploratory laparotomy was performed via a right flank incision. Approximately 120 cm of descending colon, orad to the spiral colon, was filled with doughy, ropey feces and a lack of normal fecal pellets. No mechanical obstruction was confirmed, but bowel loops orad to this area of the colon were distended with gas, and the spiral colon was empty. Minimal peristalsis was observed. Petechiae and hemorrhage were present along most of the colon orad to the spiral colon. Large amounts of abnormal feces were removed from the descending colon via enterotomy. During abdominal closure, the giraffe went into cardiac arrest, and resuscitative efforts were unsuccessful.

At necropsy, the giraffe was observed in excellent body condition with normal intra-abdominal fat stores. No significant external lesions were noted. The descending colon, orad to the spiral colon, was moderately to severely distended with undigested food material, although no lumenal obstruction was documented. Orad to this, the distal 90–120 cm of colon was empty. Multiple petechiae were present in the colon orad to the spiral colon. The urinary bladder mucosa was diffusely hemorrhagic with multifocal edema and petechiae, and the urethra was patent. Other gross necropsy findings included a moderate amount of serosanguineous tracheal fluid, a small amount of pericardial fluid, diffuse endocardial hemorrhages of the right ventricular free wall and focal hemorrhage of the right atroventricular valve, pulmonary edema and congestion, and presumed hepatic congestion. Representative samples of organs were collected and processed for histology as described for Case 1.

Histologically, petechiae were observed on the colonic mucosa and serosa, and serosal adhesions were present on one section of colon. No other gastrointestinal lesions were observed. Multiple skel-
eral muscle samples demonstrated changes consistent with acute rhabdomyolysis and early mineralization. Other histologic abnormalities included diffuse, marked pulmonary congestion and edema; mild focal neutrophilic lymphadenitis; splenic congestion; and severe, acute, focal myocardial hemorrhage. Death was attributed to acute rhabdomyolysis and toxemia associated with the functional obstruction. Tracheal, pulmonary, and splenic congestion, hemorrhage, and edema were considered agonal events. The extensive, focal, myocardial hemorrhage was attributed to resuscitative efforts.

**DISCUSSION**

In domestic ruminants, the clinical presentation of intestinal obstruction is characterized by anorexia, abdominal pain, absence of feces, passage of dark fecal blood and mucus, dehydration, acid-base imbalances, and death, if left untreated. Although the duration of clinical signs varied among the three giraffe of this report, clinical presentations were similar to those of domestic ruminants with intestinal obstructions. In all cases, clinical signs were progressive and included anorexia, decreased activity, and substantial decreases in, or total lack of, fecal production.

Clinicopathologic findings of intestinal obstructions in domestic ruminants are often nonspecific, but the most common findings are metabolic alkalosis, hypochloremia, hypokalemia, hyponatremia, azotemia, hyperglycemia, and hemoconcentration. Cases 2 and 3 of this report demonstrated many of these metabolic derangements. Case 2 was unique in demonstrating an initial marked neutrophilic leukocytosis, which is uncommon in ruminants with intestinal obstructions. The cause of the leukocytosis is unknown. Case 1 varied in that only a few mild clinical pathologic abnormalities were present. However, in one report of cattle with ileal impaction, results of hematologic and biochemical analyses were mildly abnormal in only a few animals.

In domestic ruminants, diagnosis of intestinal obstruction is often suspected based on clinical signs, clinical pathologic findings, and occasionally rectal palpation, but confirmation is usually made by exploratory laparotomy. Transabdominal ultrasonography has been a useful diagnostic aid in some cases and might be useful in giraffe trained to enter restraint chutes, but surgery would likely be required for confirmation. Exploratory laparotomies in domestic ruminants are often performed using standing sedation. In giraffe, mechanical restraint would be required for standing sedation, and a restraint device allowing easy access to the abdominal cavity would be necessary. As is the case for other species, surgical correction is the only treatment for complete physical obstruction of the intestine in ruminants, and right-sided celiotomy is the most common approach. For cases in which standing sedation is not possible, left lateral recumbency might not be well-tolerated by giraffe for a right-sided approach due to large size and rumen location, and other approaches might need to be considered. Due to their size and anatomy, giraffe are not ideal patients for abdominal surgery. However, a recent report of survival after cesarean section is encouraging. When faced with a case in which intestinal obstruction is suspected and surgical correction is probably the only curative option, early surgical intervention would be more likely to result in a favorable outcome than waiting until the patient is more substantially compromised.

The giraffe in Case 1 died secondary to phytobezoar obstruction in the spiral colon. Dysbiosis is a common sequela to intestinal dilatation and obstruction, and the overgrowth of bacteria in the jejunum was considered a secondary event. Phytobezoars are compact masses of plant material that form in the gastrointestinal tract and can lead to mucosal irritation and obstruction. Phytobezoars have been reported in several species, but are uncommon in domestic ruminants. The majority of reports have been in sheep and goats. Reports have been limited to isolated cases, cases involving young animals consuming roughage before appropriate rumen development, or cases associated with consumption of various fibrous plants.

Phytobezoars have been reported in several captive giraffe, but there are no published reports in the United States for the past 30 yr. There is at least one unpublished case of mortality secondary to obstruction of the spiral colon with a phytotrichobezoar in a giraffe in the United States (Long, pers. comm.). Descriptions of bezoar compositions are either lacking or limited to combinations of alfalfa, gravel, and sand, or limited to simply plant and food material. The phytobezoar from Case 1 was physically analyzed as containing densely packed plant material, but the types of plants were not identified. In all but two cases in which the phytobezoar location within the giraffe has been described, the phytobezoars were found within the abomasum, omasum, or rumen. In one case, the phytobezoar was located in the small intestine, and in one case it was in the spiral colon (Long, pers. comm.). In the giraffe of Case 1, the gastric compartments contained only watery ingesta, whereas the cecum contained large amounts of densely packed firm, dry, green-brown, fibrous di-
gesta. It is suspected that the phytobezoar formed in the cecum and moved aboradly; however, it may have formed within the spiral colon itself.

It has been proposed that the feeding of grass based (grazer) diets to captive giraffe, a browser species, results in passage of larger particle sizes through the rumen, which may predispose the animals to phytobezoar formation.\textsuperscript{9,20} Captive giraffe fed varying proportions of alfalfa and grass hay, pelleted compound feeds, fruits, and vegetables have been documented to have larger fecal particles than free-ranging individuals consuming their natural diets.\textsuperscript{20} Diets were not described for all giraffe reported with phytobezoars, but available descriptions include alfalfa (lucerne), \textit{Acacia nigrescens}, and grass for one individual,\textsuperscript{18} grass and alfalfa hay,\textsuperscript{12} or simply high fiber or grass diets without further elucidation.\textsuperscript{9} The giraffe in the three cases of this report were fed a complete pelleted commercial diet (Case 1: Zoo Nutrition Network\textsuperscript{20} Herbivore Diet, Mazuri, PMI Nutrition, LLC, Henderson, Colorado 80640, USA; Cases 2 and 3: ADF-16, Mazuri), alfalfa hay, intermittent browse, and produce and were observed occasionally consuming grasses or tree foliage in outdoor enclosures. Browse species offered was not always recorded, but for Case 1 it included primarily maple (\textit{Acer} sp.), willow (\textit{Salix} sp.), poplar (\textit{Populus} sp.), box elder (\textit{Acer negundo}), and hawthorne (\textit{Crataegus} sp.).

Giraffe husbandry manuals published by both the European and American Associations of Zoo and Aquaria recommend feeding captive giraffe diets consisting of browse as frequently as possible, high-quality hay, preferably alfalfa or clover, and concentrated feed (pellet; based on unmolassed beet pulp and alfalfa or grass meal, not on grains).\textsuperscript{12,26} The giraffe in Case 2 died secondary to fecal impaction of the colon, which is more common in horses and pigs than in domestic ruminants.\textsuperscript{3} Pre-disposing factors to fecal impactions in horses include coarse feed, worn teeth, and dehydration.\textsuperscript{36} In a report of a cattle with ileal impactions, impactions occurred in autumn and winter when the combination of reduced exercise, ingestion of stored feed and coarse, poor-quality hay, and reduced water intake may have predisposed to impaction.\textsuperscript{27} The giraffe of Case 2 presented in winter but had access to a large outdoor enclosure without reduced exercise, and food quality was not noted as poor. Dental disease was also not reported in this giraffe’s history or gross necropsy report. In horses, feed and fecal impactions can often be reduced with medical treatment.\textsuperscript{5} However, decisions to treat medically and delay surgery may reduce chances for survival.\textsuperscript{4} Surgical exploration is indicated in domestic ruminants if colic is persistent, abdominal distension occurs, tachycardia is present, feces are scant, abdominal “pings” indicating abomasal or cecal displacement are present, or peritoneal fluid analysis indicating intestinal devitalization is present.\textsuperscript{28} The short- and long-term prognosis after surgical intervention has been good in cattle treated for ileal impactions.\textsuperscript{27} The giraffe in Case 2 demonstrated marked metabolic derangements at the time of surgery, and the fecal impaction was not resolved. It is unknown whether earlier surgical intervention and correction would have resulted in survival post-operatively.

Cases 1 and 2 had moderately prolonged clinical courses (6 and 13 days, respectively), and histopathologic findings were suggestive of endotoxemia. It is unknown whether functional ileus was initially present and contributed to obstruction in either of these cases. In Case 1, ileus was likely secondary to phytobezoar obstruction; but in Case 2, a functional ileus may have led to fecal impaction. Ultrasound or abdominal auscultation may have been helpful in determining whether ileus was present, but they would have required the giraffe to allow such procedures or be immobilized early in the disease course. The duration of disease in domestic ruminants with colonic obstructions is frequently longer than in cases with more proximal intestinal obstructions, and endotoxemia may be present.\textsuperscript{29} The clinical course of Case 3, however, was rather acute (24 hr). Although laparotomy and gross necropsy findings were consistent with paralytic or functional colonic ileus, histopathology determined the cause of death to be secondary to acute rhabdomyolysis. In many cases of ileus, no gross lesions are present,\textsuperscript{77} and in cases of acute ileus, histopathologic lesions may not be observed in the affected intestine, especially if postmortem autolysis is present. In adult cattle with intestinal obstructions, abdominal pain is not as remarkable as in horses, but a stage of acute pain of 8–12-hr duration during which the animal kicks at its abdomen, treads uneasily with its hind legs, depresses its back, vocalizes, and occasionally rolls is not uncommon.\textsuperscript{29} The giraffe in Case 3 demonstrated signs of marked abdominal pain, including getting up and lying down, stretching, and straining repeatedly over the course of several hours. It is unknown what caused the rhabdomyolysis that led to the short clinical course in this giraffe.

The giraffe of Case 3 was diagnosed with colonic ileus. In horses, ileus is commonly reported after abdominal surgery but can also be associated with mechanical intestinal obstruction, acute inflammatory bowel diseases, peritonitis, metabolic and elec-
trotolyte imbalances (especially hypokalemia\textsuperscript{19}), and endotoxemia.\textsuperscript{24} In most species, shock, severe pain, vitamin B-complex deficiency, uremia, tetanus, diabetes mellitus, and heavy metal toxicity can cause ileus.\textsuperscript{17} The cause of ileus in domestic ruminants is often unknown,\textsuperscript{24,28} but in cattle, peritonitis and hypocalcemia are two common causes of functional obstructions.\textsuperscript{29} Hypocalcemia was not observed in the giraffe; hypocalcemia was mild, and other causes of ileus such as inflammatory bowel disease, diabetes mellitus, uremia, toxemia, tetanus, and heavy metal toxicity were not present. At necropsy, localized serosal adhesions were observed in one section of colon, which could have been consistent with a previous episode of localized peritonitis, but no other indications of peritonitis were present. Ileus in adult cattle can mimic complete intestinal obstructions,\textsuperscript{19} making it difficult to distinguish the conditions. Medical treatment can be attempted if clinical signs are mild, but surgical intervention is indicated when signs are severe or persistent. Soon after exploratory laparotomy many cattle begin passing feces despite lack of correction of any specific underlying defect.\textsuperscript{19} The giraffe of Case 3 died secondary to rhabdomyolysis, and it is unknown whether it would have survived after surgical intervention if rhabdomyolysis had not been present.

In conclusion, fatal colonic obstructions were reported in three captive, adult, reticulated giraffe. Clinical presentations varied but all cases displayed decreased activity, anorexia, and substantially decreased fecal production, consistent with intestinal obstruction. Two cases underwent surgical intervention but were markedly compromised by the time of surgery. Gastrointestinal obstruction should be considered in giraffe in which anorexia and greatly decreased fecal production are observed. Clinical pathologic abnormalities may be relatively mild. Ultrasonography and rectal palpation may aid in diagnosing distended loops of intestines in animals trained to enter a chute and allow manipulation. Aggressive treatment, including intravenous fluid therapy, and surgical intervention, should be considered early in the course of the illness. Abdominal exploratory surgery will likely be necessary for diagnostic confirmation and disease resolution. Although surgical intervention was not successful in this report, it is the only curative treatment for mechanical gastrointestinal obstructions, and it might result in a successful outcome if pursued early, before the patient becomes markedly compromised. Based on the three cases presented in this report, gastrointestinal obstruction in giraffe has a poor prognosis.

\textbf{Acknowledgments:} We thank Dr. Michael Kinsel and the University of Illinois Zoological Pathology Program; Dr. Christopher Gregory and the Infectious Disease Laboratory, Department of Small Animal Medicine, University of Georgia College of Veterinary Medicine; and Dr. Michael Garner and Northwest ZooPath for pathology services and editorial suggestions. We also thank the zookeepers and veterinary departments at Brookfield Zoo, Riverbanks Zoo, and Indianapolis Zoo for dedication to the health of the animals in their care.

\textbf{LITERATURE CITED}

14. Ensley, P. K., T. L. Rost, M. Anderson, K. Benir-

Received for publication 21 June 2008