

# Ultrasonographic findings in horses with right dorsal colitis: five cases (2000–2001)

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**Objective**—To determine whether ultrasonography would be useful in the diagnosis of right dorsal colitis in horses.

**Design**—Retrospective study.

**Animals**—5 horses with right dorsal colitis and 15 healthy adult horses.

**Procedure**—Mural thickness and appearance of the right dorsal colon were determined from ultrasonographic images obtained at right intercostal spaces 10, 11, 12, 13, and 14.

**Results**—The right dorsal colon could be imaged most consistently at the right 11th, 12th, and 13th intercostal spaces, below the margin of the lung and axial to the liver. Mural thickness measured from ultrasonographic images was significantly greater in horses with right dorsal colitis than in healthy horses. The right dorsal colon in affected horses had a prominent hypoechoic layer associated with submucosal edema and inflammatory infiltrates. Successful treatment of 1 horse with right dorsal colitis was associated with a decrease in mural thickness coincident with an increase in serum albumin and total protein concentrations and weight gain. A decrease in mural thickness was also observed in a second horse treated for right dorsal colitis that was not associated with healing of the right dorsal colon or an increase in serum albumin concentration but rather thinning of a segment of the right dorsal colon that eventually ruptured.

**Conclusions and Clinical Relevance**—Results suggest that ultrasonographic measurement of mural thickness and evaluation of the appearance of the right dorsal colon may be useful in the diagnosis of right dorsal colitis in horses. (*J Am Vet Med Assoc* 2003;222:1248–1251)

In horses, right dorsal colitis (RDC) has been associated with administration of nonsteroidal anti-inflammatory drugs, particularly phenylbutazone,<sup>1,2</sup> and is characterized by mucosal ulceration, edema, neutrophilic inflammation, and mural thickening of the right dorsal colon.<sup>1,3</sup> The prognosis for horses with RDC is guarded,<sup>1,3</sup> but this may in part be attributable to the fact that antemortem diagnosis of RDC is difficult, and the diagnosis is often delayed until the disease is in an advanced stage. The degree of tissue inflammation and ulceration increases, and the lesions become more fibrotic and contain more granulation tissue as the duration of the disease increases,<sup>2</sup> lessening the likelihood for a favorable outcome. Thus, early and accurate diagnosis is critical to successful treatment of RDC.

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Other conditions that must be considered in the differential diagnosis of horses with signs consistent with RDC include sand enteropathy, cyathostomiasis, chronic inflammatory bowel disease, alimentary lymphosarcoma, gastric ulcer disease, and chronic salmonellosis. A definitive diagnosis cannot be made solely on the basis of clinical signs, because they are not specific for RDC. Surgical exploration via laparoscopy or celiotomy is currently the most accurate method for diagnosis of RDC,<sup>2</sup> although scintigraphy with radiolabeled leukocytes has also been described as a diagnostic test for RDC.<sup>4</sup> However, both of these methods are costly and require specialized facilities and equipment. Exploratory celiotomy carries risks associated with the procedure that make this method of diagnosis undesirable in most cases.

Ultrasonography has previously been reported<sup>5</sup> to be useful for diagnosis of RDC in a single horse. Ultrasonographic examination of the right dorsal colon is an attractive diagnostic test, because it is noninvasive, has a low risk of adverse effects, and can be done with readily available equipment. Our hypothesis is that ultrasonography is useful in the diagnosis of RDC in horses. The purposes of the study reported here were to establish a method for ultrasonographic examination of the right dorsal colon in horses, determine ultrasonographic features of the right dorsal colon in healthy horses, and determine whether the ultrasonographic features of the right dorsal colon in horses with RDC are different from those in healthy horses.

## Criteria for Selection of Cases

All horses referred to the North Carolina State University Large Animal Hospital between January 1, 2000, and January 1, 2002, in which a diagnosis of RDC was made and ultrasonographic examination of the right dorsal colon had been performed were included in the study. A presumptive diagnosis of RDC was made on the basis of history and physical examination findings, identification of hypoproteinemia and hypoalbuminemia, and results of diagnostic tests that ruled out other conditions that cause similar signs. The diagnosis was confirmed at necropsy in horses that died or were euthanatized. Fifteen healthy adult horses of similar size and breed (2 Arabians, 2 Thoroughbred-Quarter Horse crosses, 6 Quarter Horses, and 5 Quarter Horse mixed-breed crosses) ranging from 2 to 18 years old served as controls for image analysis.

## Procedures

**Ultrasonography**—With a No. 40 blade, hair was clipped from an area on the right side of the trunk bounded by the 9th intercostal space cranially, the 17th

intercostal space caudally, a horizontal line at the level of the shoulder dorsally, and a diagonal line at the approximate ventral border of the lung field ventrally. Ultrasonographic transducing gel<sup>a</sup> was applied, and ultrasonography<sup>b</sup> was performed with a 3.5- or 5-MHz curvilinear transducer or a 3.5-MHz sector scanning transducer, depending on the size of the horse and the image quality. Ultrasonographic images were obtained on the right side by starting at the ventral border of the lung and scanning in a dorsal-to-ventral plane at the 10th through 15th intercostal spaces. Images were captured digitally<sup>c</sup> and printed.<sup>d</sup> The peripheral wall of the right dorsal colon was identified lying immediately axial and ventral to the liver, ventral to the duodenum, and dorsal to the right ventral colon.<sup>6</sup> The right dorsal colon could be distinguished from the right ventral colon by the lack of haustra.<sup>6</sup> The junction between the right dorsal colon and right ventral colon could be identified by the axial deviation of the wall of each segment of colon, forming a V-shaped image. The right ventral colon was imaged ventral this junction, below the costochondral margin. The right dorsal colon could not be distinguished from the base of the cecum by appearance but was distinguished for the purposes of this study by its location relative to the liver and the right ventral colon. Thickness of the right dorsal colon wall at each intercostal space where the right dorsal colon was identified was measured electronically. For this measurement, mural thickness of the right dorsal colon was defined as the distance from the serosal edge of the colon to the edge of the mucosal layer. Echogenicity and ability to distinguish the various layers of the right dorsal colon wall were also determined. An image of the right ventral colon served as a control for the right dorsal colon. The ratio of right dorsal colon-to-right ventral colon thickness was calculated by dividing mural thickness of the right dorsal colon at the 12th intercostal space by mural thickness of the right ventral colon at that space.

**Statistical analysis**—For each intercostal space for which sufficient observations were available, mural thickness of the right dorsal colon in affected horses was compared with mural thickness of the right dorsal colon in control horses. In affected and control horses, mural thickness of the right dorsal colon measured at the 12th intercostal space was compared with mural thickness of the right ventral colon. Finally, the ratio of right dorsal colon-to-right ventral colon thickness was compared between affected and control horses. The Mann-Whitney rank sum test was used for all analyses, because the data were not normally distributed. Values of  $P < 0.05$  were considered significant.

## Results

Five horses with RDC met the criteria for inclusion in the study. Two were Quarter Horses, 1 was a Thoroughbred, 1 was a Standardbred, and 1 was a Quarter Horse-Thoroughbred cross. Three were geldings and 2 were mares. Horses ranged from 5 to 20 years old. Two horses had been treated with flunixin meglumine, 1 had been treated with phenylbutazone, and 2 had been treated with both drugs at different times prior to diagnosis of RDC. All 5 horses were

being treated with a nonsteroidal anti-inflammatory drug at the time of onset of clinical signs of RDC. Two horses had clinical evidence of dehydration and reduced tissue perfusion (ie, prolonged capillary refill time, poor pulse strength, cool extremities, or high anion gap) at the time that administration of the nonsteroidal anti-inflammatory drug was begun. Two had undergone general anesthesia for a surgical problem at the time that administration of the nonsteroidal anti-inflammatory drug was begun.

Four of the 5 horses with RDC had a history of recent colic or were examined because of colic. All 5 horses had a history of diarrhea, weight loss, partial anorexia, and signs of depression associated with the probable onset of RDC. Two had edema of the limbs and ventral midline. Two had a fever, and 3 had tachycardia at the time of initial examination for RDC. Three horses were anemic, 2 had leukocytosis, 4 had neutrophilia or neutropenia, and 3 had band neutrophilia. None had hyperfibrinogenemia. All 5 horses had hypoproteinemia and hypoalbuminemia. One of 3 in which peritoneal fluid analysis was performed had a high peritoneal fluid WBC count.

The right dorsal colon could be imaged in all affected and control horses at the right 11th and 12th intercostal spaces, in 1 affected horse and 4 control horses at the 10th intercostal space, in 4 affected and 9 control horses at the 13th intercostal space, and in 1 affected and 2 control horses at the 14th intercostal space (Table 1). Mural thickness of the right dorsal colon at the 11th ( $P = 0.001$ ), 12th ( $P = 0.001$ ), and 13th ( $P = 0.007$ ) intercostal spaces was significantly greater in affected than in control horses. Values for mural thickness of the right dorsal colon at the 10th and 14th intercostal spaces could not be compared between affected and control horses, because there were too few measurements in affected horses. The ratio of right dorsal colon-to-right ventral colon thick-

Table 1—Median mural thickness of the right dorsal colon and right ventral colon, measured ultrasonographically, in 5 horses with right dorsal colitis and 15 healthy adult horses

Segment	Horses with right dorsal colitis		Healthy horses	
	No. of horses	Thickness (cm)	No. of horses	Thickness (cm)
Right dorsal colon				
10th intercostal space	1	1.67	4	0.34 (0.27–0.41)
11th intercostal space	5	1.17 (0.85–1.54)	15	0.35 (0.24–0.59)*
12th intercostal space	5	0.90 (0.82–1.57)	15	0.36 (0.22–0.45)*
13th intercostal space	4	0.87 (0.72–1.59)	9	0.33 (0.24–0.59)*
14th intercostal space	1	0.63	2	0.42 (0.30–0.55)
Right ventral colon	5	0.43 (0.32–0.57)†	15	0.36 (0.23–0.51)
RDC:RVC	5	2.46 (2.0–3.3)	14	1.01 (0.7–1.6)*

Data are given as median (range). Thickness of the right ventral colon was measured at the 12th intercostal space. RDC:RVC = Ratio of the right dorsal colon-to-right ventral colon thickness (measured at the 12th intercostal space).  
\*Significantly ( $P < 0.01$ ) different from value for affected horses.  
†Significantly ( $P < 0.01$ ) different from value for the right dorsal colon in affected horses.

ness was significantly ( $P < 0.001$ ) greater in affected horses than in control horses. Mural thickness of the right dorsal colon was significantly ( $P < 0.008$ ) greater than mural thickness of the right ventral colon measured at the 12th intercostal space in affected horses, but mural thickness of the right dorsal colon was not significantly different from mural thickness of the right ventral colon in control horses, and mural thickness of the right ventral colon in control horses was not significantly different from mural thickness of the right ventral colon in affected horses.

Echogenicity pattern of the right dorsal colon in affected horses was different from the pattern in control horses. In the affected horses, a hypoechoic layer was present bordered by a hyperechoic layer on the serosal and mucosal sides (Fig 1). The echogenicity of this hypoechoic layer was less than the echogenicity of the liver. The effect of this hypoechoic layer was to disrupt the stratification of the layers of the colon. The thickness of the hypoechoic layer varied from  $< 50$  to  $> 75\%$  of the total mural thickness.

Two of the 5 affected horses were treated for presumptive RDC. One was still alive 2 years later; the other died 3 months after diagnosis of RDC following rupture of the right dorsal colon. In the horse that survived, mural thickness of the right dorsal colon measured at the 12th intercostal space decreased from 1.57 cm at the time of diagnosis to 1.05 cm after 30 days of treatment and 0.55 cm after 60 days of treatment.

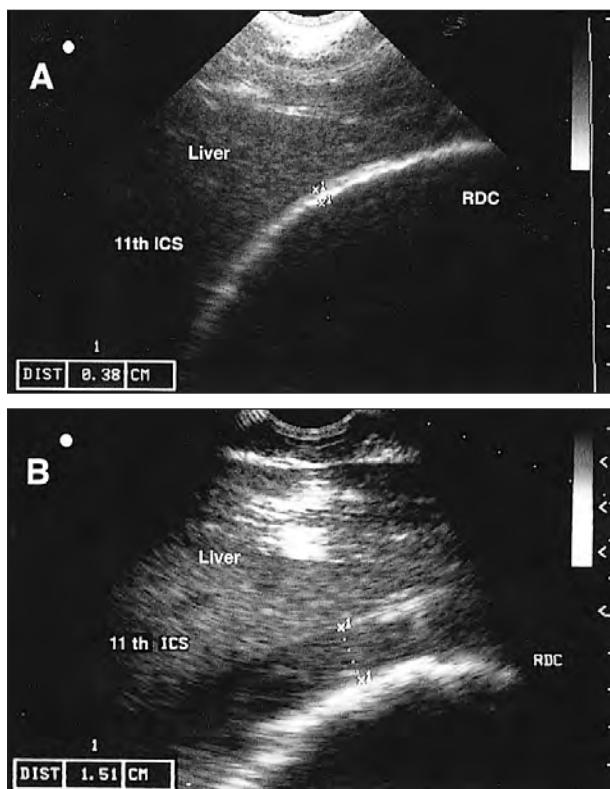


Figure 1—Ultrasonographic images of the right dorsal colon (RDC) in a healthy adult horse (A) and a horse with right dorsal colitis (B). Images were obtained at the right 11th intercostal space (ICS) ventral to the margin of the lung. Dorsal is to the left. The wall of the RDC is indicated by the cursors. Notice the marked thickening of the RDC in the horse with right dorsal colitis versus the healthy horse. A prominent hypoechoic layer is evident in the wall of the RDC in the affected horse.

Coincident with this decrease in mural thickness, serum albumin and total protein concentrations increased and were within reference limits after 60 days. In addition, the horse gained weight, and all clinical signs resolved. In the horse that died, mural thickness of the right dorsal colon measured at the 11th, 12th, and 13th intercostal spaces decreased to the range of values for control horses after 60 days of treatment (0.35, 0.31, and 0.38 cm, respectively), but the hypoechoic layer was still present. Serum albumin (1.2 g/dL) and total protein (3.8 g/dL) concentrations did not increase with treatment, and the horse had persistent peripheral edema and a poor appetite despite treatment.

Four of the 5 horses with RDC died or were euthanized. All 4 had marked coalescing mucosal ulceration of the right dorsal colon. The right dorsal colon was ruptured at a thin area of ulceration in the horse that had been treated but did not survive. The right dorsal colon was thicker than normal in all 4 horses (0.9 to 1.1 cm vs 0.3 to 0.4 cm for the right ventral colon). Unfortunately, we were unable to determine whether the site at which right dorsal colon thickness was measured at necropsy matched any site at which right dorsal colon thickness was measured ultrasonographically antemortem. Microscopic examination of the right dorsal colon revealed severe neutrophilic hemorrhagic colitis with ulceration, submucosal edema, and congestion in all 4 horses. Two horses had blood clots adhered to the ulcerated mucosa. One horse had moderate diffuse eosinophilic colitis in all segments of the large intestine, including areas of the right dorsal colon. Three of the 4 horses had interstitial nephritis with tubular epithelial degeneration. One horse had papillary necrosis.

## Discussion

Results of the present study indicated that the right dorsal colon could most reliably be imaged ultrasonographically at the 11th, 12th, and 13th intercostal spaces in horses with RDC and healthy control horses but could also be imaged in some horses at the 10th and 14th intercostal spaces. It was difficult to reliably differentiate the right dorsal colon from the base of the cecum at the 15th intercostal space. In addition, it was difficult to observe the 5 layers of the right dorsal colon in images obtained from control horses. All of the horses with RDC had a hypoechoic layer that appeared to correspond to submucosal edema, inflammatory cellular infiltrates, and granulation tissue observed on post-mortem examination. In healthy horses and horses with RDC, the mucosa was relatively hyperechoic, and it was difficult in some instances to distinguish the luminal edge of the mucosal layer from the colonic contents. This was more difficult in control horses than in horses with RDC. This raises the possibility that we overestimated the colonic thickness in some control horses. Despite this, there was still a significant difference between ultrasonographically measured mural thickness in control horses versus horses with RDC.

In the present study, mural thickness of the right dorsal colon measured ultrasonographically was significantly greater in horses with RDC than in control horses. The thickness measured on the ultrasonographic image appeared to correlate with the actual

thickness in the 4 horses in which right dorsal colon thickness was measured at necropsy. Moreover, thickness of the right dorsal colon was significantly greater than thickness of the right ventral colon in horses with RDC. Thus, the ratio of right dorsal colon-to-right ventral colon thickness was significantly greater in horses with RDC than in control horses. These data suggest that ultrasonography may be a useful method of evaluating the right dorsal colon in horses suspected to have RDC. Calculation of the ratio of right dorsal colon-to-right ventral colon thickness may be useful when evaluating the right dorsal colon in horses substantially larger or smaller than the horses included in the present study.

In the 2 horses treated for RDC, mural thickness of the right dorsal colon measured ultrasonographically decreased to the range of values for control horses within 60 days of treatment. In the horse that survived, this reduction in mural thickness coincided with clinical recovery and an increase in serum albumin concentration to reference limits. However, in the horse that did not survive, the serum albumin concentration remained low, and the peripheral edema persisted. In addition, postmortem measurements demonstrated that the right dorsal colon was thin in the area of the rupture but abnormally thick elsewhere. Thus, it remains to be seen whether measuring mural thickness of the right dorsal colon is a useful method for monitoring response to treatment in horses with RDC.

Some authors have suggested that the sensitivity of ultrasonography for diagnosis of RDC is low.<sup>3</sup> Although our data do suggest that ultrasonography may be useful in the diagnosis of RDC, the sensitivity and specificity of ultrasonography cannot be determined from this study. One drawback of ultrasonography as a diagnostic test for RDC is that it may not be possible to image the affected portion of the right dorsal colon. A second drawback is that mural thickness

may be in the range of values for healthy horses in a horse with severe ulceration of the right dorsal colon, as was observed in this study. Interoperator variation may also affect measurements obtained ultrasonographically.

In summary, results of our study suggest that mural thickness of the right dorsal colon measured ultrasonographically reflects the actual thickness, and that ultrasonography may be useful in the diagnosis of RDC in horses. However, more work must be done to determine the sensitivity and specificity of ultrasonography as a diagnostic test for RDC and the repeatability of ultrasonographic measurements of the right dorsal colon.

<sup>a</sup>Aquasonic transducing gel, Parker Laboratories Inc, Orange, NJ.

<sup>b</sup>Opus Impact, Diasonics Ultrasound, Santa Clara, Calif.

<sup>c</sup>MVC FDR3 Mavicap Digital Still Image Capture Adaptor, Sony, San Jose, Calif.

<sup>d</sup>UP 890MD Videographic Printer, Sony, San Jose, Calif.

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