Duodenal obstruction caused by duodenal sigmoid flexure volvulus in dairy cattle: 29 cases (2006–2010)

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Objective—To characterize duodenal sigmoid flexure volvulus (DSFV) and determine the prognosis for affected cattle undergoing surgery.

Design—Retrospective case series.

Animals—29 dairy cattle.

Procedures—The medical records were analyzed for history, signalment, clinical signs, medical management, surgical findings, and outcome.

Results—29 cattle were determined to have DSFV between December 2006 and August 2010. Twenty cattle had had an omentopexy or pyloropexy performed 1 day to 2 years before initial evaluation. Cattle were afebrile, tachycardic, and moderately dehydrated, with a small zone of percussion with a ping at the 10th to 12th right intercostal spaces and associated succussion. Biochemical changes were a severe hypokalemic (mean ± SD, 2.9 ± 0.5 mmol/L; median, 3.1 mmol/L; range, 2.08 to 3.92 mmol/L), hypochloremic (mean, 69.7 ± 11.1 mmol/L; median, 71.7 mmol/L; range, 49.1 to 94.1 mmol/L) metabolic alkalosis (mean total CO_2, 44.5 ± 7.4 mmol/L; median, 45.3 mmol/L; range, 31.5 to 59.6 mmol/L) and hyperbilirubinemia (mean, 32.4 ± 29.0 μmol/L; median, 20.5 μmol/L; range, 7.8 to 107 μmol/L). Surgical findings for DSFV included an empty descending duodenum adjacent to a dorsally displaced and dilated cranial segment of the duodenum, distended abomasum and gallbladder, and a tight volvulus at the base of the duodenal sigmoid flexure. Manual reduction was considered successful if the descending duodenum filled after cranial duodenal massage. Twenty-two patients were successfully treated; the remaining 7 died or were euthanized within 4 days after surgery.

Conclusions and Clinical Relevance—A condition clinically resembling abomasal volvulus but affecting the duodenal sigmoid flexure has been recognized in dairy cattle. When a focal, dorsal right-sided ping and succussion are present combined with severe hypokalemic, hypochloremic metabolic alkalosis and high bilirubin concentration, DSFV should be suspected, especially when there is a history of prior abomasal fixation. After surgical correction, the prognosis is fair to good. (*J Am Vet Med Assoc* 2012;241:621–625)

In ruminants, the duodenal anatomy is unique with respect to its increased length and mobility within the abdomen. From the pylorus, the cranial duodenum courses toward the liver, where it forms the sigmoid flexure prior to returning caudally and becoming the descending duodenum. The duodenal sigmoid flexure has a double attachment to the greater (caudally) and lesser omentum (cranially).[1]

Naturally occurring proximal duodenal obstructions are uncommon in cattle. Reported cases include functional stenoses or strictures, liver abscesses causing cranial abdominal adhesions involving the duodenum, phytobezoars, trichobezoars, and a report of gallbladder entrapment.[2–5] In a retrospective study[4] comparing naturally occurring proximal duodenal obstructions with AV in cattle, significant differences were found with respect to the metabolic changes. The hypochloremic metabolic alkalosis was more severe in cattle with duodenal obstruction.

Recently, we have recognized a new condition clinically resembling AV but affecting the duodenal sigmoid flexure in dairy cattle. The purpose of the study reported here was to characterize DSFV and determine the prognosis for affected cattle undergoing surgery.

Abbreviations

AV	Abomasal volvulus
DSFV	Duodenal sigmoid flexure volvulus

Materials and Methods

Case selection—Medical archives from January 2000 through August 2010 from the Université de

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Montréal's veterinary teaching hospital and the Université de Montréal's ambulatory service were searched for cattle determined to have DSFV at surgery and were included in the present study. Keywords searched for in the diagnosis, surgery report, or letter to the referring veterinarian included duodenum with distension, volvulus, torsion, or ileus.

Medical records review—Data obtained from the records included age, breed, sex, days in lactation, and pregnancy status. Additional information obtained included clinical signs and duration, physical examination findings, results of blood gas or serum biochemical analyses, medical imaging, surgical findings, and patient survival rate. Descriptive statistics (mean ± SD and median and range) were calculated for patient data, serum biochemical analysis results, and fluid therapy volumes.

Outcome—The survival rate was calculated as the number of cattle discharged from the teaching hospital and those remaining in the herd (when treated by the ambulatory service) divided by the total number of patients with DSFV. A Fisher exact test was used to compare survival rate of animals treated at the veterinary teaching hospital versus on the farm. Follow-up information was obtained by telephone interviews with the owners by use of a standardized questionnaire at least 3 months after surgery. Data obtained included whether the animal was still in the herd, production since surgery (milking, calving, and embryo or semen production), reason for elimination from the herd, and necropsy results when available.

Results

No records were found of this condition before December 2006. Twenty-nine Holstein cattle from 28 farms were determined to have DSFV between December 2006 and August 2010, including 28 females and 1 male. Nineteen of these cattle were managed in the veterinary teaching hospital, and 10 were managed on the farm by the ambulatory service. The mean age at initial evaluation was 4.5 years (median, 5 years; range, 2 to 8 years). Milking cows (n = 24) were a mean of 80 days in lactation (median, 60 days; range, 1 to 300 days in lactation). Four cows were not lactating, and 3 were due to calve within 2 weeks following initial evaluation. Sixteen of the cattle were examined within 1 day after the owner noticed signs of anorexia, signs of depression, colic, and an absence of feces. Nine cattle were examined within 3 days after the onset of clinical signs, and 4 were evaluated after ≥ 4 days.

On physical examination, the cattle were afebrile (mean, 38.4°C [101.12°F]; range, 37.6° to 39.3°C [99.68° to 102.74°F]) and tachycardic (103 beats/min; range, 68 to 160 beats/min); most cattle were moderately dehydrated (5% to 7% [n = 8], > 7% to 10% [8], or > 10% to 12% [5]) and had no feces present in the rectum (26). By simultaneous auscultation and percussion, a cranial, right-sided ping located dorsally at the 10th to 12th intercostal spaces was recorded for 24 animals. This ping was associated with succussion, by shaking the body to detect a splashing sound of fluid, for 17 animals. Severe hypochloremic, hypokalemic metabolic alkalosis was a common finding (**Table 1**). Changes indicating cholestasis and hepatocellular damage were seen on serum biochemical analysis.

In animals for which preoperative ultrasonography was performed and the results were available (n = 11), a large gallbladder (total length, 15 cm) was noted in 8 cattle, as was 1 or 2 distended loops of duodenum (diameter, > 6 cm) in 9 (**Figure 1**). In all animals, marked abomasal distention was noted on ultrasonography.

Twenty cattle had previously undergone omentopexy (n = 19) or pyloropexy (1) 1 day to 2 years before the initial evaluation (mean, 243 ± 237 days; median, 150 days). Five of the cattle had the pexy performed within 3 days prior to surgery for DSFV, and 15 had a pexy performed at least 6 months beforehand. In those animals, the pexy was bluntly or sharply dissected at surgery to allow a better evaluation of the cranial duodenum and sigmoid flexure.

Intravenous fluid therapy was initiated before surgical preparation began and was continued during surgery. Antimicrobials were administered prophylactically before the start of surgery. The surgical approach was a standard right flank laparotomy with a paravertebral nerve block. When a previous laparotomy had been performed within ≤ 2 weeks, abdominal access was obtained via the initial

Table 1—Serum biochemical values obtained from 25 cattle (1 male and 24 females) with DSFV.

Variable	Value	Reference range
K^+ (mmol/L)	2.9 ± 0.5 (3.1; 2.08–3.92)	3.8–5.3
Cl^- (mmol/L)	69.7 ± 11.1 (71.7; 49.1–94.1)	96.4–109.2
Total CO_2 (mmol/L)	44.5 ± 7.4 (45.3; 31.5– 59.6)	22.0–33.0
Bilirubin (µmol/L)	32.4 ± 29.0 (20.5; 7.8–107)	0–14.0
γ-Glutamyltransferase (U/L)	213.8 ± 288.0 (61; 19–984)	9.6–39.0
Glutamate dehydrogenase (U/L)	349.6 ± 270.0 (146; 0.4–2,390)	3.0–45.0

Data are reported as mean ± SD (median; range).
Blood was not collected from 4 cattle.

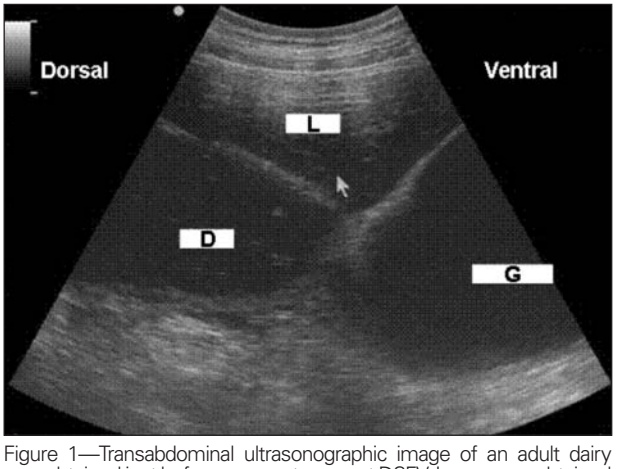


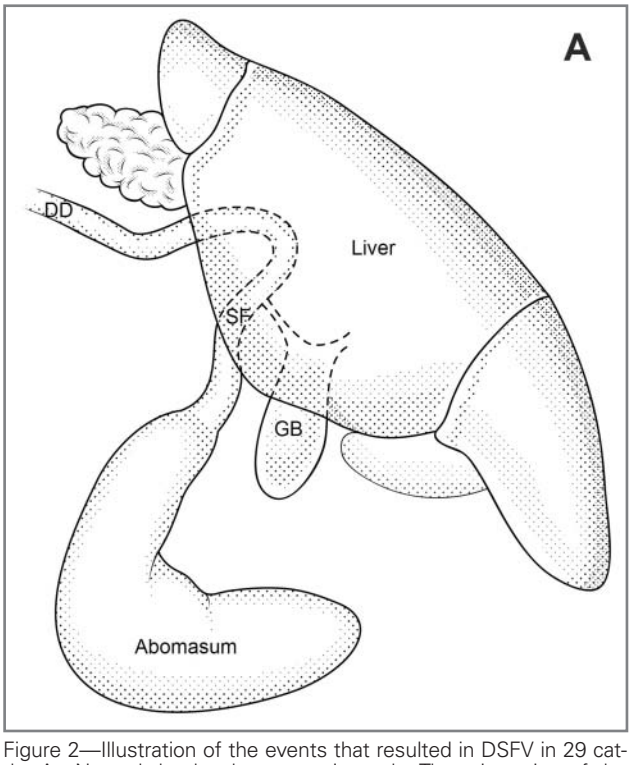
Figure 1—Transabdominal ultrasonographic image of an adult dairy cow obtained just before surgery to correct DSFV. Image was obtained from the right 10th intercostal space with a curvilinear 3.5-MHz transducer. A dilated cranial segment of the duodenum with mildly heterogenic contents is evident medial to the liver and dorsal to an extremely dilated gallbladder. A diagnosis of DSFV was confirmed during right flank laparotomy, in which a tight twist at the omental attachment of the sigmoid flexure was palpated, in addition to a distended and turgid cranial segment of the duodenum and gallbladder and ventrally located abomasum. D = Duodenum. G = Gallbladder. L = Liver.

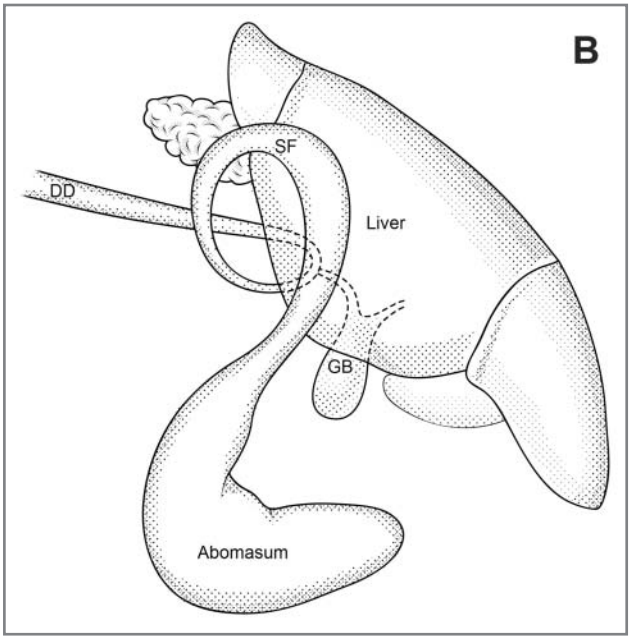
incision. When approaching the abdomen of a cow with a mature omentopexy, the incision was made cranial to the laparotomy scar whenever possible.

Surgical findings included an empty descending duodenum adjacent a dorsally displaced and dilated cranial duodenum, distended abomasum and gallbladder, and a tight volvulus at the base of the duodenal sigmoid flexure. The DSFV was carefully palpated at its liver attachment for masses and adhesions. Manual reduction of the volvulus was considered successful if the descending duodenum filled after cranial duodenal massage. No attempts were made to pexy the sigmoid flexure. In 7 surgeries, omentopexy or another type of abomasal fixation was performed prior to closing the abdomen. In all other cases, the weight associated with the abomasal distension precluded abomasopexy or omentopexy. The incision was routinely closed in 3 layers, and the wound was copiously lavaged with sterile saline (0.9% NaCl) solution in between each layer.

Focal peritonitis or duodenal necrosis was noted during surgery in 9 cattle. In 1 cow, duodenal perforation was found after the volvulus was reduced. The borders of the lesion were white, and a perforated duodenal ulcer was suspected. The perforation was closed with a double-layer Cushing pattern. A duodenoduodenostomy between the cranial duodenum and the descending duodenum was performed with a stapler[a] as described previously.[6] Another cow had peritonitis localized around the site of pyloropexy and a nonperforated ulcer of the cranial duodenum. The pexy suture was cut to free the pylorus from the body wall, and no further manipulations of this area were attempted. The duodenal ulcer was oversewn with a single-layer Cushing pattern with 2-0 absorbable, synthetic suture to prevent perforation.

All animals received IV fluid therapy and antimicrobials; 19 cattle received NSAID treatment. A mean of 90 L of isotonic crystalloid fluids (median, 80 L; range, 20 to 200 L; n = 23) was administered for a mean of 2.5 days (range, 1 to 5.5 days). Hospitalized cattle received a mean of 94 L (median, 80 L; range, 30 to 200 L; n = 19) of isotonic fluids. Cattle managed on the farm received a mean of 35 L (median, 30 L; range, 20 to 60; n = 4) of isotonic fluids. Of the other cattle managed on the farm,





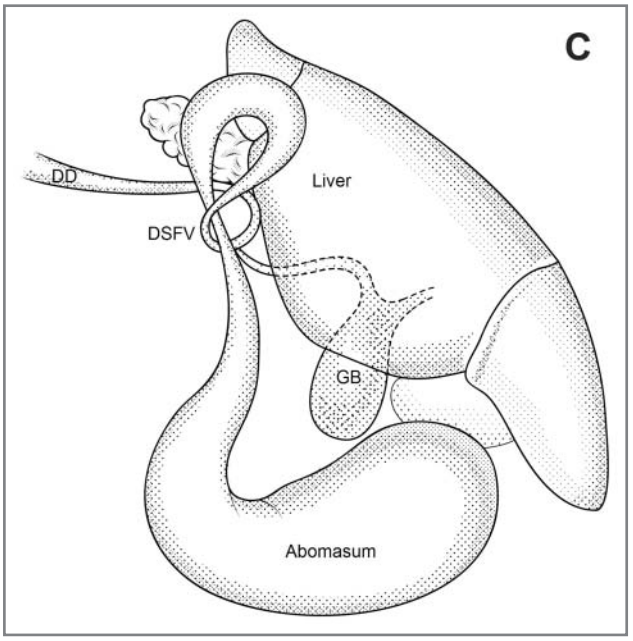


Figure 2—Illustration of the events that resulted in DSFV in 29 cattle. A—Normal duodenal anatomy in cattle. The orientation of the sigmoid flexure and location of the common bile duct can differ between animals. B—Initially, the ventral portion of the sigmoid flexure has displaced dorsally, and the cranial segment of the duodenum is located further dorsally. The cranial flexure of the duodenum has not displaced and is represented by the dotted line. In 3 of 29 cattle, only dorsal displacement without progression to volvulus had occurred, as illustrated. C—DSFV, with counterclockwise volvulus of the sigmoid flexure occluding the common bile duct, causing gallbladder engorgement and further dorsal displacement of the cranial segment of the duodenum. The cranial flexure does not displace. DD = Descending duodenum. GB = Gallbladder. SF = Sigmoid flexure.

4 received only hypertonic saline (7.5% NaCl) solution (150 g in 2 L of warm water, IV) and calcium borogluconate, and 2 cattle received 50% dextrose. Antimicrobial use included injectable trimethoprim-sulfamethoxazole, procaine penicillin G, ampicillin, and oxytetracycline given individually or in combination. The mean duration of antimicrobial treatment was 7.5 days (median, 7 days; range, 3 to 12 days). Most cattle received antimicrobials IV for the first 3 to 5 days after surgery and then received penicillin IM for the remaining duration of treatment.

Outcome—Twenty-two of the 29 (76%) cattle were successfully managed. For 21 of these animals, appetite and fecal production returned to normal within a mean of 4 days after surgery (median, 4 days; range, 3 to 10 days), and milk production for lactating cows progressively returned to previous amounts. Sixteen of 19 hospitalized patients and 6 of 10 patients treated on the farm survived.

Of the 16 animals examined within 1 day after the onset of clinical signs, 15 survived; of the 9 treated within 3 days after the onset of clinical signs, 5 survived; and of the 4 animals that had clinical signs for > 3 days, 2 survived. Duodenal sigmoid flexure volvulus did not reoccur; however, reduction was impossible in 2 animals. On necropsy of the 7 nonsurvivors, including the 2 in which the volvulus could not be reduced, severe duodenal edema and peritonitis implicating the bile duct were found. These were 7 of the 9 animals with evidence of duodenal necrosis or focal peritonitis at surgery. The 2 animals with peritonitis that survived were previously described as having duodenoduodenostomy and peritonitis at the site of pyloropexy.

Follow-up information was obtained for all surviving cattle. Two cows were sent to slaughter, including one because of old age (it completed 4 lactations since treatment for DSFV) and the other because of poor milk production (production had decreased for 3 consecutive lactations, with DSFV occurring during the last lactation). One cow died on the farm 2 months after discharge from the veterinary teaching hospital. It was the 1 animal for which appetite had only marginally improved after surgery, and appetite remained mediocre until natural death. No necropsy was performed. At follow-up, the bull was still in service at the insemination center, with > 100,000 doses of its semen being collected 2 to 3 times/wk. The remaining 18 cows stayed with their herds and continued to meet their owners' expectations for milk production, fertility, or use in embryo transplantation programs. Interestingly, the cow that had the duodenoduodenostomy performed was finishing its second lactation and reportedly performing better after the surgery than before the surgery. No reoccurrences were reported, and no other cattle on each the farms were determined to have DSFV.

Discussion

Duodenal sigmoid flexure volvulus should be suspected in dairy cattle with a dorsally located, focal, right-sided ping and succussion combined with severe hypokalemic, hypochloremic metabolic alkalosis and elevated values for liver variables on serum biochemical profile, especially when there is a history of prior abomasal fixation. The prognosis for DSFV is fair to good whether the animals are managed on the farm or in the hospital. Aggressive fluid therapy to correct dehydration and electrolyte imbalances is important for a successful outcome.

On the basis of our medical records, this condition has only recently been recognized. All patients were managed under the direct supervision of experienced clinicians, who are in agreement that this is a problem that has been seen within the past 5 years. Medical records were examined dating back to January 1960 with the same search criteria, and no records were found from 1960 to December 2006. This may be due to changes in archiving methods, but when taking into consideration the collective experience of the clinicians, we feel that this condition has only recently developed. This condition clinically resembles AV but affects the duodenal sigmoid flexure, and it is possible that by constantly breeding for larger, taller dairy cattle, even more mobility of the sigmoid flexure has been inadvertently created.

To create DSFV, the sigmoid flexure first displaces in a dorsolateral direction (in a counterclockwise direction if the cow is seen from behind), which places what was the ventral part of the sigmoid flexure and cranial duodenum at the level of the descending duodenum (**Figure 2**). To create the volvulus, the displaced duodenum rotates around its omental attachments (in a counterclockwise direction if the cow is viewed dorsally, as for AV). In 3 of the 29 cattle in the present study, the surgeons believe that only the dorsal displacement had occurred (ie, no volvulus); therefore, the reduction was simply replacing the sigmoid flexure. We hypothesize that once the sigmoid flexure displaces dorsally, it cannot fall back into place (as can occur with a floating displaced abomasum) and must be manually reduced. Even without the volvulus, these cattle had the classic manifestation: history of omentopexy, clinical examination findings of focal right-sided ping and succussion, and marked serum biochemical profile changes.

The etiology of this displacement and volvulus is still uncertain. The unique nature of this condition and its recent occurrence bring up many questions. Further studies are needed to evaluate risk factors such as diet, husbandry, and calving history. Previous abomasal fixation in 20 of 29 cattle is an interesting finding. We hypothesize that the animals reoperated within days after omentopexy or pyloropexy had duodenal disease from the beginning but that it was originally missed because this condition was not well-known. For those animals that developed DSFV months to years after omentopexy, we suggest that the pexy leaves the cranial duodenum more mobile without the normal tension from the abomasum, allowing it to more easily displace dorsally.

In cattle with DSFV, the passage of ingesta through the proximal duodenum is completely occluded, marked distension of the cranial duodenum and abomasum occurs, and thus acid secretion increases. The values obtained from cattle with DSFV are in agreement with other reports[2–4,7,8] of naturally occurring and experimentally induced proximal duodenal obstruction

in ruminants. Because of the location of the distal accessory pancreatic duct in cattle and no reports of pancreatitis at necropsy, we do not feel that the volvulus affected pancreatic function.

With DSFV, the common bile duct is included in the volvulus, causing mechanical obstruction of the gallbladder, cholestatsis, and the subsequent engorgement seen ultrasonographically and palpated during surgery. It is also responsible for the marked elevation in bilirubin seen on the serum biochemical profile of most affected cattle.

When peritonitis, duodenal ulceration, or perforation is present, the prognosis is poor. The recognition of duodenal pathological changes, including ulceration, perforation, or stenosis, may indicate the need for a duodenoduodenostomy to restore abomasal outflow. Ulcers are painful, and when ≥ 1 are present, motility changes are likely to occur, possibly predisposing these cattle to DSFV. The subsequent peritonitis that follows can make DSFV reduction more difficult as seen in the 2 cattle of the present study, in which reduction was impossible despite multiple attempts.

The severity of the hypokalemia brings up the question of whether the cattle were hypokalemic first (with associated paralytic ileus) and then DSFV developed or whether the volvulus occurred first and caused the hypokalemia. When duodenal obstructions were experimentally created in sheep, the changes seen were not significant because of the marked variations in serum potassium concentrations between test subjects.[7] However, experimental duodenal obstruction in calves created hypokalemia.[8] Constable et al[3] reported serum potassium concentrations of 3.6 mmol/L for cattle with AV and 3.2 mmol/L for cattle with proximal duodenal obstruction. The mean serum potassium concentration for the patients in our study was 2.9 ± 0.5 mmol/L (median, 3.1 mmol/L; range, 2.08 to 3.92 mmol/L), which is similar to values reported[3] for cattle with duodenal ileus.

In a field setting, serum biochemical analysis results will likely be of limited value in making a timely diagnosis and surgical intervention. However, marked hypokalemia and hypochloremia should be considered when creating a treatment plan. Sterile placement of a jugular catheter will facilitate the IV administration of antimicrobials and large quantities of isotonic crystalloid fluids (> 60 L) supplemented with calcium. Fluid administration IV is recommended for at least the first 24 to 48 hours after surgery with administration of potassium (150 g of KCl/adult animal, PO, q 12 h for 3 days),[9] and veterinary vehicles should be stocked accordingly, or resources should be readily available. Aggressive fluid therapy to restore known or assumed electrolyte imbalances is imperative for managing cattle with DSFV.

The prognosis for survival and return to production is fair to good on the basis of our results. Additionally, we suggest that the decision not to pexy the duodenum does not seem to favor recurrence of this condition. Veterinarians must be aware of this emergent syndrome in cattle. More cases and further studies are needed to determine the etiology of this new condition.

a. GIA 80 Auto Suture reloadable stapler, 4.8 mm, Tyco Healthcare, Norwalk, Conn.

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