Circumcaval ureter associated with an intrahepatic portosystemic shunt in a dog

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Case Description—A 4-month-old Bernese Mountain Dog was examined because of shifting hind limb lameness and lethargy of 2 weeks' duration.

Clinical Findings—The lameness was attributed to hypertrophic osteodystrophy. Portosystemic shunting was suspected on the basis of low serum albumin concentration and high serum bile acids concentration, and an intrahepatic shunt was identified ultrasonographically. Celiotomy was performed, and the shunt was partially closed with a cellophane band. During follow-up ultrasonography 7 months later, dilation of the left renal pelvis and proximal portion of the left ureter was identified. During exploratory celiotomy, the left ureter was found to pass dorsal to the caudal vena cava, and circumcaval ureter was diagnosed.

Treatment and Outcome—The ureter was transected, repositioned ventral to the vena cava, and anastomosed. Follow-up ultrasonographic examinations revealed gradual resolution of the hydronephrosis and hydroureter.

Clinical Relevance—Findings suggest that circumcaval ureter should be considered in the differential diagnosis for hydronephrosis and hydroureter in dogs. Partial obstruction of the middle segment of the ureter on ultrasonograms or contrast radiographs should increase the index of suspicion for this condition. (*J Am Vet Med Assoc* 2006;228:389–391)

A 4-month-old sexually intact female Bernese Mountain Dog was referred for evaluation of shifting hind limb lameness and lethargy of 2 weeks' duration. Prior to referral, treatment with meloxicam (0.1 mg/kg [0.045 mg/lb], PO, q 24 h) and exercise restriction had resulted in mild clinical improvement.

Results of a complete physical examination, including orthopedic and neurologic examinations, performed at the time of admission were unremarkable, except for pyrexia (rectal temperature, 39.6°C [103.2°F]) and signs of pain during manipulation of both stifle joints and the lumbar portion of the vertebral column. Routine hematologic and serum biochemical testing was performed, along with survey radiography of all 4 limbs, survey radiography of the abdomen and thorax, and ultrasonography of the abdomen.

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Hematologic and serum biochemical abnormalities included hypoalbuminemia (23 g/L; reference range, 29 to 36 g/L), leukocytosis (21.3 × 10^9 cells/L; reference range, 6.0 to 12.0 × 10^9 cells/L), neutrophilia (13.2 × 10^9 cells/L; reference range, 3.0 to 11.8 × 10^9 cells/L), lymphocytosis (5.1 × 10^9 cells/L; reference range, 1.0 to 4.8 × 10^9 cells/L), and monocytosis (2.6 × 10^9 cells/L; reference range, 0.15 to 1.35 × 10^9 cells/L). Because serum albumin concentration was low, serum bile acids concentrations were measured before and 1 and 2 hours after the dog ate. At all 3 time periods, serum bile acids concentration was high (baseline, 49.1 µmol/L [reference range < 10 µmol/L]; 1 hour after eating, 274.4 µmol/L [reference range < 15 µmol/L]; and 2 hours after eating, 317.3 µmol/L [reference range < 15 µmol/L]).

On survey radiographs of the limbs, changes consistent with hypertrophic osteodystrophy were seen involving the distal aspects of the radius and ulna in both forelimbs and the distal aspect of the tibia in both hind limbs. On radiographs of the abdomen, the liver appeared subjectively to be smaller than normal and an undefined expansion of the cranioventral aspect of the fourth lumbar vertebra was seen. Abdominal ultrasonography revealed a dilated vessel on the right side of the liver, close to the diaphragm, that could be traced from the portal vein to the caudal vena cava. Turbulent flow was detected in this vessel by means of color-flow Doppler ultrasonography, and findings were considered consistent with an intrahepatic portosystemic shunt. Both kidneys were ultrasonographically normal, with no evidence of dilation of the renal pelves or proximal portions of the ureters. A urine sample was obtained by means of ultrasound-guided cystocentesis; no abnormalities were detected on urinalysis, and bacterial culture did not yield any growth.

The dog was discharged, and the owners were instructed to administer meloxicam (0.1 mg/kg, PO, q 24 h), lactulose (0.5 mg/kg [0.23 mg/lb], PO, q 8 h), neomycin (20 mg/kg [9 mg/lb], PO, q 8 h), and amoxicillin-clavulanic acid (12.5 mg/kg [5.68 mg/lb], PO, q 12 h) and to feed a proprietary diet ad libitum. Four weeks later, the dog was readmitted for surgical treatment of the portosystemic shunt. A cranial midline celiotomy was performed. No clinically important abnormalities other than the portosystemic shunt were detected on exploration of the abdomen. A 20-gauge, over-the-needle catheter was inserted in a mesenteric vein and connected to a water manometer to monitor portal pressure during surgery. The portal vein was dissected in the area of the porta hepatis, and the branch leading to the portosystemic shunt was identified where it entered the right lateral lobe of the liver. Complete occlusion of the shunt resulted in a marked

increase in portal pressure, as identified with the manometer, and clinical indications of portal hypertension, including intestinal hypermotility and intestinal and pancreatic cyanosis. To allow for gradual attenuation of the shunt, a cellophane band adjusted to approximately half the original diameter of the shunt was applied. There were no appreciable clinical signs of portal hypertension during the subsequent 10 minutes; therefore, the abdomen was closed. The dog was discharged 2 days after surgery with instructions to continue the previous medications.

The dog was reexamined 8 weeks after surgery. Serum bile acids concentrations were still greater than the upper reference limit (baseline, 27.9 µmol/L; 1 hour after eating, 65.9 µmol/L; and 2 hours after eating, 58.6 µmol/L), and although an area of shunt attenuation could be identified ultrasonographically, blood flow in the portal vein still had a pulsatile quality, indicative of ongoing shunting. No anomalies of the urinary tract were seen ultrasonographically. The owner was advised to continue with medical management as previously prescribed and to return the dog in 3 months for further evaluation.

Seven months after surgery, the dog was reexamined. At that time, the owner reported that the dog had periods of waxing and waning lethargy. Serum bile acids concentrations, measured by the referring veterinarian, were greater than the upper reference limit (baseline, 48.9 µmol/L; and 1 hour after eating, 55.2 µmol/L). Abdominal ultrasonography was performed. The area of vessel attenuation was identified, and no flow could be demonstrated through the region of interest. Examination of the left kidney revealed marked hydronephrosis and distention of the proximal portion of the left ureter extending to the midlumbar region where the ureter appeared to end abruptly and could not be imaged further caudally. Diameter of the renal pelvis was 15 mm. Serum creatinine and BUN concentrations were within reference limits. The dog was anesthetized, and IV urography was performed. Contrast was excreted by the left kidney, demonstrating dilation of the renal pelvis and proximal portion of the left ureter (**Figure 1**).

Twenty-four hours later, the dog was again anesthetized and a midline celiotomy was performed. The dilated left ureter was identified and followed to a point where the middle third of the ureter passed dorsal to the caudal vena cava. The caudal portion of the ureter was found to attach to the bladder in the correct position. This was followed craniad until it passed dorsal to the caudal vena cava in the same area as the cranial segment. The ureter passed dorsal to the caudal vena cava from left (lateral) proximally to right (medial) distally. Peristalsis was evident in the caudal segment but not in the cranial segment. The retroperitoneum and other connective tissues were dissected to mobilize the ureter. Following dissection, it was possible to move the ureter proximal to distal. Following placement of stay sutures, the ureter was transected through the dilated segment close to the vena cava and positioned so it was ventral to the vena cava. The ends of the ureter were then anastomosed with simple interrupted sutures of 5-0 polyglecaprone 25. Exploration of the site of the portosystemic shunt was attempted but deemed impractical owing to the large amount of fibrous tissue and adhesions in the area. The abdomen was flushed with warm saline solution and closed routinely.

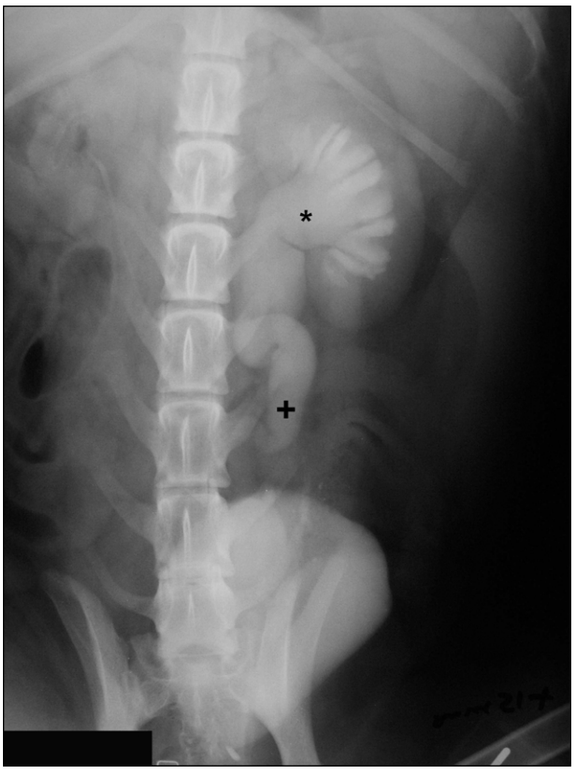

Figure 1—Ventrodorsal radiographic projection of the abdomen of a dog obtained 15 minutes after IV administration of contrast medium. Notice the dilation of the left renal pelvis (*) and the proximal portion of the ureter (+) to the level of the fifth lumbar vertebra.

The dog was discharged 2 days after surgery, and the owner was instructed to administer meloxicam (0.1 mg/kg, PO, q 24 h). Four weeks after the second surgery, the dog was reexamined, at which time the owner reported that the dog was much brighter. Ultrasonography of the left kidney and ureter demonstrated continued dilation of the renal pelvis and ureter. The renal pelvis was 9 mm in diameter at its widest point, compared with 15 mm prior to surgery.

The dog was examined because of bilateral forelimb lameness 4.5 months after the second surgery, and bilateral fragmented medial coronoid processes were diagnosed on the basis of computed tomographic findings. Abdominal ultrasonography was performed, and although the left renal pelvis was still dilated, it was only 4 mm in diameter at the widest point. The proximal portion of the left ureter appeared normal ultrasonographically.

Discussion

Retrocaval or circumcaval ureter (the terms are used interchangeably) is an unusual condition that has been identified occasionally in people[1-14] but has not, to our knowledge, been previously identified in dogs. It is considered to be a congenital malformation of the vena

cava, rather than the ureter.[1,2,6,14] The presumed pathogenesis is development of the caudal vena cava from the right subcardinal vein, which lies ventral to the ureter, rather than the supracardinal vein, which lies dorsal to the ureter.[2,14] Most reported cases involve the right side,[5,14] and cases of left-sided circumcaval ureter are usually associated with situs inversus or major anomalies such as branchial arch syndrome,[5] a complex consisting of unilateral craniofacial and vertebral anomalies.

Exposure to diethylene glycol monomethyl ether has been shown experimentally to cause circumcaval ureter in rabbits[15] and was implicated as the cause in a previous case report.[13] Diethylene glycol monomethyl ether is an industrial solvent used in the production of resins, lacquers, dyes, paints, and inks[13] and was unlikely to have been involved in development of circumcaval ureter in the dog described in the present report.

Concomitant congenital abnormalities have been reported in 21% of human patients with circumcaval ureter,[14] including vascular anomalies,[4,6,14] partial situs inversus,[7] glandular hypospadia,[9,14] supernumerary lumbar vertebra,[14] syndactylia,[14] and intestinal malrotation.[16] The dog described in the present report was originally examined because of a congenital intrahepatic portosystemic shunt, and circumcaval ureter was identified during a follow-up examination.

In people with a circumcaval ureter, the ureter may become obstructed as a result of extrinsic or intrinsic factors.[1] Extrinsic obstruction is a result of pressure from the aberrant caudal vena cava on the ureter, whereas intrinsic obstruction develops secondary to stenosis or hypoplasia of the ureter.[1,11] In people, it is recommended that the affected portion of the ureter be resected or carefully examined to ensure there is no stenosis or hypoplasia.[11] The affected portion of the ureter was not resected in the dog described in the present report, and this may have contributed to the slow resolution of hydronephrosis. Ultimately, however, this did not adversely affect the outcome.

In most people with circumcaval ureter, the condition is identified during the third or fourth decade of life,[1] but the condition has been reported in juveniles.[1,9] Although the condition is most often asymptomatic, a minority of affected patients have flank pain.[14] In the dog described in the present report, circumcaval ureter was detected at an early age during routine abdominal ultrasonography following portosystemic shunt surgery. Although the ureter was not specifically examined at the time of portosystemic shunt ligation, gross dilation was not visible during surgery or during abdominal ultrasonography performed prior to and immediately after surgery. This might indicate that chronic partial extrinsic obstruction had progressed with growth. Although the possibility that dilation was a result of ureterolithiasis was not specifically investigated during surgery, there was no evidence of ureterolithiasis during diagnostic imaging.

A fishhook appearance of the ureter during IV urography is considered diagnostic of circumcaval ureter, although different diagnostic procedures,[14] such as retrograde ureteropyelography or contrast computed tomography, are required in some instances. Three-dimensional volume-rendered computed tomography combined with diuretic renography allows highly accurate anatomic delineation of the ureter and identification of any obstruction.[17]

Circumcaval ureter should be considered in the differential diagnosis for hydronephrosis and hydroureter in dogs. Partial obstruction of the middle segment of the ureter on ultrasonograms or contrast radiographs should increase the index of suspicion for this condition.

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