

Prevalence and radiologic and histologic appearance of vesicourachal diverticula in dogs without clinical signs of urinary tract disease

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Objective—To determine prevalence and radiologic and histologic appearance of vesicourachal diverticula in dogs without clinical signs of urinary tract disease.

Design—Original study.

Animals—50 dogs between 4 months and 17 years old representing 22 breeds that had been euthanatized for unrelated reasons; none of the dogs had a history or clinical signs of urinary tract disease.

Procedure—Retrograde positive-contrast radiography was performed, and radiographs were examined for macroscopic diverticula. Necropsy specimens from the urinary bladder vertex were examined by means of light microscopy for diverticula and signs of inflammation.

Results—17 of the 50 (34%) dogs had vesicourachal diverticula, and 1 additional dog had a urachal cyst. Fifteen of the 17 diverticula were macroscopic; surface area of the diverticulum could be measured radiographically in 13 of these dogs and ranged from 1 to 90 mm². The remaining 2 diverticula were microscopic. Sixteen diverticula were intramural and 1 was extramural. Light microscopic signs of bladder wall inflammation could be detected in 5 dogs, 4 of which had macroscopic diverticula.

Conclusions and Clinical Relevance—Results suggest that a high percentage of dogs without clinical signs of urinary tract disease may have vesicourethral diverticula. Further studies are needed to determine the clinical relevance of vesicourethral diverticula in dogs. (*J Am Vet Med Assoc* 2005;226:383–386)

The urachus is the fetal communication between the urinary bladder and the allantois and allows urine to pass from the urinary bladder into the allantoic sac of the placenta. At birth, the urachus is nonfunctional, but mechanisms responsible for its atrophy are not clearly defined.^{1,2} Four types of congenital urachal anomalies have been identified in humans and other

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animals: persistent urachus, urachal cyst, urachal sinus, and vesicourachal diverticulum.^{2,3} Vesicourachal diverticula are the most commonly recognized urachal anomaly.^{4,5}

By definition, a diverticulum is a circumscribed pouch or sac of variable size occurring normally or created by herniation of the lining mucous membrane through a defect in the muscular coat of a tubular organ. A vesicourachal diverticulum is described as a triangular, circular, or rectangular appendix to the urinary bladder vertex.^{2,6} Its appearance may be classified as microscopic or macroscopic, and its location may be classified as intramural or extramural.^{2,3} Microscopic vesicourachal diverticula are defined as islands of transitional epithelium of various sizes with a microscopic lumen that may not always be identified. Macroscopic vesicourachal diverticula are grossly visible on positive-contrast radiographs and are limited to the thickness of the bladder wall (intramural) or protrude beyond the serosal surface of the urinary bladder (extramural).³

Vesicourachal diverticula have been identified in dogs with chronic or recurrent bacterial cystitis,^{1,7,8} suggesting that there may be an association between vesicourachal diverticula and urinary tract disease. To our knowledge, however, the prevalence of vesicourachal diverticula in dogs without urinary tract disease has not been determined. Therefore, the purpose of the study reported here was to determine prevalence and radiographic and histologic appearance of vesicourachal diverticula in dogs without clinical signs of urinary tract disease.

Materials and Methods

Animals—Fifty dogs without any clinical signs of urinary tract disease that were euthanatized for reasons unrelated to the present study were examined. Reasons for euthanasia included cardiac insufficiency (n = 11), osteoarthritis (9), vertebral neoplasia (2), mammary neoplasia (1), nasal neoplasia (1), cerebral neoplasia (2), appendicular neoplasia (3), splenic neoplasia (1), gastric torsion (1), neuromuscular disease (1), peripheral neuropathy (1), pyometra (1), aggression (2), glaucoma (2), trauma (hit by car; 3), and pyoderma (1). Five dogs were euthanatized at the owner's request; for the remaining 3 dogs, the reason for euthanasia was not obtained.

For all dogs, a history was obtained and a physical examination was performed by 1 of 2 individuals (KG or TT) prior to euthanasia; however, a urinalysis was not performed, and urine samples were not submitted for bacterial culture. None of the dogs had any clinical signs of dysuria, polyuria, oliguria, anuria, stranguria, or hematuria, and signs of pain were not evident during abdominal palpation. Owners did not report any clinical signs of urinary tract disease at the time of euthanasia.

Dogs were euthanatized by means of IV administration of thiopental sodium (10 mg/kg [4.5 mg/lb]). Immediately after dogs were euthanatized, a flexible urinary catheter was placed to completely empty the urinary bladder. Gross appearance of the urine was normal in all dogs.

Radiologic examination—To fix the urinary bladder in situ, a 1:4 mixture of the water-soluble positive contrast medium iopamidol^a in 4% formalin was instilled into the urinary bladder through the urinary catheter. Volume of fluid instilled in milliliters was equal to body weight of the dog in kilograms. Following fluid instillation, the catheter was closed or kinked to prevent the mixture from escaping and a lateral radiographic view of the abdomen was obtained.

All radiographs were examined by a single individual (TT). Radiologically apparent diverticula were classified as macroscopic vesicourachal diverticula. For urinary bladders with triangular vesicourachal diverticula, surface area of the diverticulum was calculated by use of the following formula: surface area = $0.5 \times \text{length} \times \text{base width}$.

Light microscopic examination—A caudal midline celiotomy was performed, and the urinary bladder was grossly examined. A 2 × 2-cm piece of the cranial part of the bladder centered on the bladder vertex was taken within 15 minutes after euthanasia and immersion fixed in buffered 4% formalin. Tissue samples were embedded in paraffin, and 4- μm -thick sections of the samples were obtained and stained with H&E.

Sections were examined by means of light microscopy by a single individual (ME). Diverticula identified only by means of light microscopy were classified as microscopic vesicourachal diverticula. Light microscopy was also used to differentiate between intramural and extramural macroscopic diverticula.

Statistical analyses—Summary data were calculated. Age and sex distributions for dogs with diverticula were compared with distributions for dogs without diverticula by means of χ^2 tests. Standard statistical software^b was used. Values of $P < 0.05$ were considered significant.

Results

Signalment—Nineteen of the 50 dogs were of mixed breeding, with the remaining 31 dogs representing 21 breeds. There were 4 German Shepherd Dogs, 3 Yorkshire Terriers, 2 Collies, 2 Rottweilers, 2 Dachshunds, 2 Bernese Mountain Dogs, 2 Pekingese, 1 Great Dane, 1 Schnauzer, 1 Bobtail, 1 Golden Retriever, 1 Leonberger, 1 Irish Setter, 1 Airedale Terrier, 1 Entlebucher, 1 Münsterländer, 1 Kaukasian Hütehund, 1 Akita Inu, 1 Spaniel, 1 Lhasa Apso, and 1 Poodle. Twenty-nine dogs were male and 21 were female. Dogs ranged from 4 months to 17 years old, with 4 dogs < 12 months old, 14 dogs between 1 and 9 years old, and 32 dogs > 10 years old. Mean \pm SD age of the dogs was 10.4 ± 4.4 years.

Radiologic findings—Fifteen of the 50 (30%) dogs had radiographic evidence of a macroscopic vesicourachal diverticulum. Mean \pm SD age of dogs with macroscopic vesicourachal diverticula was 10.1 ± 5.0 years; 9 were male and 6 were female. Age distribution of dogs with macroscopic diverticula was not significantly different from age distribution of dogs without. The vesicourachal diverticulum was triangular in 14 dogs (Figure 1). In the remaining dog, the diverticulum had a teardrop shape (Figure 2), indicating extramural protrusion of the diverticulum.

Surface area of the diverticulum could be calculated in 13 of the 14 dogs with a triangular diverticulum. Mean \pm SD surface area was $30.4 \pm 30 \text{ mm}^2$ (range, 1 to 90 mm^2). In the remaining dog, surface area of the diverticulum could not be calculated because the mixture of iopamidol and formalin was not uniformly distributed in the diverticulum.

Light microscopic findings—Seventeen of the 50 (34%) dogs were determined to have vesicourachal diverticula by means of light microscopic examination of bladder specimens. Fifteen of these were the dogs with macroscopic diverticula evident on positive-contrast radiographs; the remaining 2 dogs had microscopic diverticula that were evident only during light microscopic examination. In addition to these 17 dogs, 1 dog had an intramural urachal cyst. The 2 dogs with microscopic diverticula were 12 and 15 years old; the dog with the urachal cyst was 4 months old. Again, age distribution of dogs with vesicourachal diverticula was not significantly different from age distribution of dogs without.



Figure 1—Lateral positive-contrast radiographic view of the abdomen in a dog. Notice the triangular macroscopic vesicourachal diverticulum.

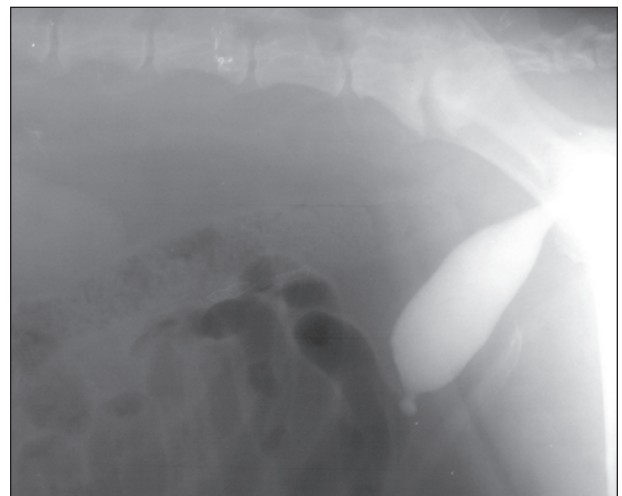


Figure 2—Lateral positive-contrast radiographic view of the abdomen in a dog. Notice the cystic macroscopic vesicourachal diverticulum.

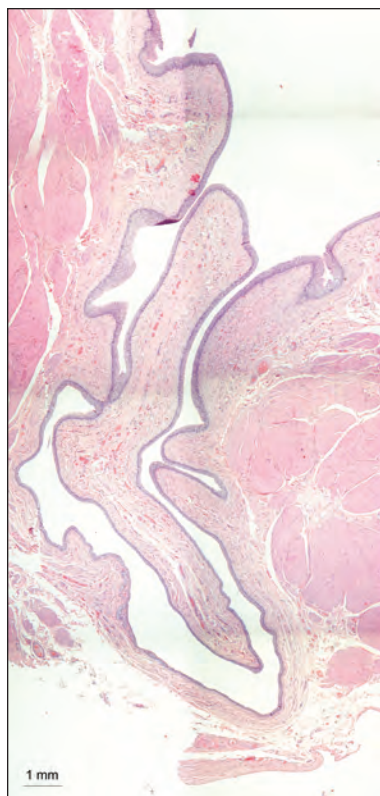


Figure 3—Photomicrograph of a section of the bladder from the dog in Figure 2. Notice the ample lumen of the diverticulum reaching through the full width of the bladder wall. H&E stain; bar = 1 mm.

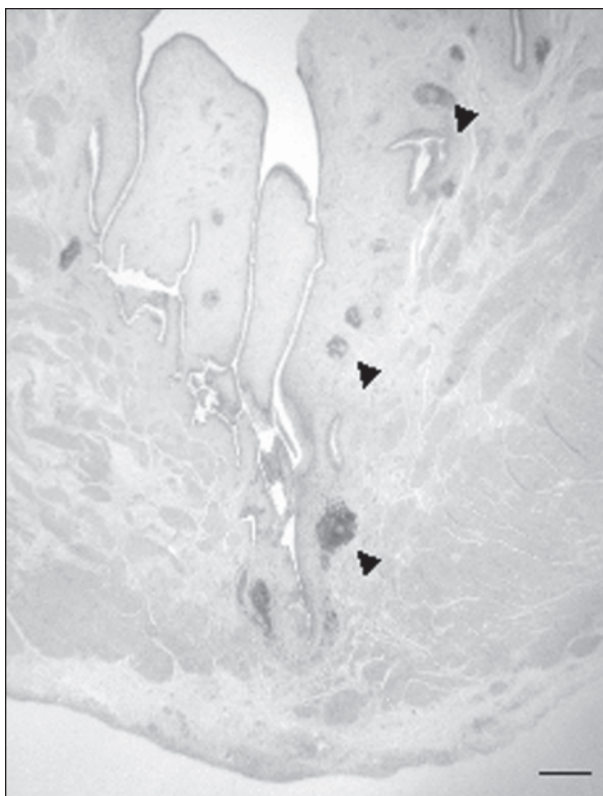


Figure 4—Photomicrograph of a section of the bladder from a dog with a macroscopic diverticulum. Notice the large number of lymphoid follicles below the epithelium (black arrowheads). H&E stain; bar = 1 mm.

Only 1 of the 17 vesicourachal diverticula was classified as extramural. In this dog, the protrusion was continuous throughout the bladder wall with a vesicular appendage, confirming the radiologic results (Figure 3). The remaining vesicourachal diverticula were intramural. They consisted of a ductlike indentation that protruded into the muscle layer.

Signs of chronic inflammation, as evidenced by diffuse lymphocytic infiltration and lymph follicles in the lamina propria and submucosa of the bladder mucosa but not in the muscularis propria, were seen in 5 of the 50 dogs. Four of these 5 dogs had a macroscopic intramural vesicourachal diverticulum (Figure 4). In these dogs, lymphocytic infiltration was found in close proximity to the diverticulum. The remaining dog with lymphocytic infiltration did not have any evidence of a vesicourethral diverticulum.

Discussion

Although several veterinary textbooks⁹⁻¹² refer to the existence of vesicourachal diverticula in dogs, to the authors' knowledge, there is a lack of information on their prevalence. In the present study, 17 of 50 (34%) dogs without any clinical signs of urinary tract disease had radiographic or light microscopic evidence of vesicourachal diverticula, suggesting that they are not uncommon.

Vesicourachal diverticula have been associated with chronic inflammatory diseases of the urinary tract in cats,^{2,13} dogs,^{1,7,8} and people.¹⁴ Three case

reports^{1,7,8} described vesicourachal diverticula in dogs with chronic cystitis, and another case report¹⁵ cited persistent urachal ligaments as a reason for recurring cystitis in a Bernese Mountain dog and a Golden Retriever. However, the concomitant presence of vesicourachal diverticula and chronic inflammatory disorders of the lower urinary tract does not prove a cause-and-effect relationship. One aim of the present study was to determine whether vesicourachal diverticula could be found in dogs without clinically apparent urinary tract disease. For this reason, dogs with a history of urinary tract disease were excluded from this study.

Light microscopic evaluation of bladder diverticula (but not vesicourachal diverticula) in humans revealed chronic inflammation in 81% of resected diverticula.¹⁶ The inflammation was attributed to poor contractility of the diverticulum, resulting in urine stasis. In the present study, light microscopic signs of chronic inflammation were seen in 5 dogs, 4 of which had macroscopic intramural diverticula. Escape of noninfectious antigenic substances normally confined to urine into the tissues at the site of the vesicourachal diverticulum could have resulted in the microscopic inflammation that was seen.

The design of the present study did not permit us to determine whether macroscopic diverticula were acquired or congenital. A study³ of the biological behavior of vesicourachal diverticula in cats suggested that microscopic urachal remnants that persist in the urinary bladder vertex after birth are usually silent, but represent a risk factor for development of macroscopic vesicourachal diverticula. An abnormal or sustained increase in bladder intraluminal pressure associated with lower urinary tract disorders may cause enlargement or tearing of microscopic diverticula, leading to development of macroscopic vesicourachal diverticula.

The population of dogs included in the present study was quite diverse. The large number of dogs > 9 years old probably resulted from the fact that more older dogs are euthanatized. The small number of young (< 1 year old) and middle-aged (between 1 and 9 years old) dogs did not allow us to detect a statistical

association between age and the presence of diverticula. In a previous study,⁶ vesicourachal diverticula were found in 27% of male and 14% of female cats, and a separate study¹¹ suggested that male cats are twice as likely to acquire vesicourachal diverticula as are females. In the present study, 10 of 17 dogs with vesicourachal diverticula were male and 7 were female.

Detection of macroscopic vesicourachal diverticula by means of positive-contrast radiography is a reliable technique.² In human medicine, vesicourachal diverticula were often serendipitously detected during abdominal ultrasonography or computed tomography.¹⁷ Both excretory urography and contrast-enhanced cystography are able to reveal disorders of the urinary bladder vertex in animals.^{3,6,7,9,10} With our technique for positive-contrast radiography, the urinary bladders were well filled, but not overdistended, with sufficient contrast medium for identification and classification of vesicourachal diverticula.

Whereas vesicourachal diverticula reportedly can be triangular, circular, or rectangular, most of the diverticula in the present study were triangular. Variability of surface area measurements in the present study may be related to variations in degree of urachus atrophy, differences in bladder wall thickness, and fibrosis subsequent to chronic inflammation. A difference in filling pressures between dogs is another possible explanation for the different sizes of vesicourachal diverticula. In addition, type, severity, and duration of initiating diseases may have contributed to different measurements of vesicourachal diverticula. The present study did not concentrate on measuring the filling pressure before euthanasia and during contrast radiography.

Two diverticula in the present study were detected only by means of light microscopy and were not visible on contrast radiographs. The reason for this was most probably related to the fact that these dogs had a thin bladder wall and a diverticulum with a conelike opening toward the bladder lumen. Therefore, filling the bladder with contrast medium could have spread the diverticulum so that it was not macroscopically detectable.

Determining the clinical relevance of the results of the present study requires additional study to determine whether the findings are coincidental or have a cause-and-effect association with chronic urinary tract

infection. Further studies in dogs with urinary tract disease are necessary to underline the clinical importance of vesicourachal diverticula in dogs with chronic or recurrent infectious or noninfectious cystitis.

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- a. Jopamiro, Gerot Pharmazeutika, Vienna, Austria.
b. SPSS, version 11.5 for Windows, SPSS Inc, Chicago, Ill.
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