# Complications and outcomes following rectal pull-through surgery in dogs with rectal masses: 74 cases (2000–2013)

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**Objective**—To evaluate the incidence of and factors associated with complications following rectal pull-through (RPT) surgery and the outcome for dogs with rectal tumors.

**Design**—Retrospective case series.

**Animals**—74 dogs with rectal masses.

**Procedures**—Information regarding signalment, history, diagnostic testing, type of rectal disease, surgical details, and postoperative complications, treatments, and outcomes was obtained from medical records and follow-up communications. Survival times were calculated. Descriptive statistics were generated. Regression analyses were used to evaluate the effect of various variables on the development of postsurgical complications and survival time.

**Results**—58 (78.4%) dogs developed postsurgical complications, the most common of which was fecal incontinence with 42 (56.8%) dogs affected, of which 23 (54.8%) developed permanent incontinence. Other complications included diarrhea (n = 32), tenesmus (23), stricture formation (16), rectal bleeding (8), constipation (7), dehiscence (6), and infection (4). The rectal tumor recurred in 10 dogs. The median survival time was 1,150 days for all dogs and 726 days for dogs with malignant tumors. The 2 most common rectal masses were rectal carcinoma and rectal carcinoma in situ, and the dogs with these tumors had median survival times of 696 and 1,006 days, respectively.

**Conclusions and Clinical Relevance**—Dogs with rectal diseases that underwent RPT surgery had a high incidence of complications; however, those dogs had good local tumor control and survival times. The risk and impact of postsurgical complications on the quality of life and oncological outcomes should be discussed with owners before RPT surgery is performed in dogs with rectal masses. (*J Am Vet Med Assoc* 2014;245:684–695)

In dogs, diseases of the rectum and anocutaneous junction are uncommon but important clinical conditions that include various rectal and cutaneous neoplasms, rectal strictures, diverticula, perforations, fistulae, and trauma.[1,2] Surgery is frequently the preferred treatment for most of these diseases, but can be challenging because the surgical approach to the distal portion of the rectum is complicated by the regional anatomy, which increases the potential for postoperative complications.[3–6] Thus, several approaches have been described, including the ventral approach, dorsal inverted-U approach, pull-out or rectal mucosal eversion with submucosal resection, endoscopic electrosurgical resection, and RPT (transanal or combined abdominal-transanal) approach.[1,3–12]

The ventral approach involves either a sagittal pubic osteotomy or bilateral pubic and ischial osteotomies.[7–9] The major perceived drawback to this approach is that it involves an invasive technique to achieve adequate exposure of the diseased tissue; however, results of multiple studies[7–9] indicate that dogs develop minimal complications and rapidly return to ambulation following osteotomy. The outcome of this approach for the treatment of dogs with rectal neoplasms is vari-

**Abbreviations**

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| CI | Confidence interval |
| MCT | Mast cell tumor |
| MST | Median survival time |
| RPT | Rectal pull-through |

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able. In 1 study,[9] use of a sagittal pubic osteotomy via a ventral approach for treatment of dogs with rectal neoplasms generally resulted in a poor outcome, with 6 of 7 dogs developing postsurgical complications. However, the results of that study[9] should be interpreted with caution because 3 dogs had extensive metastatic lesions and were euthanized at the time of surgery and the other 3 dogs died of unknown causes. Conversely, results of another study[7] that involved 6 dogs and 1 cat with rectal tumors indicate good results following a bilateral pubic osteotomy and ischial osteotomy approach for tumor resection.

The dorsal approach involves an inverted-U incision that begins at an ischiatic tuberosity, extends dorsal to the anus, and terminates at the contralateral ischiatic tuberosity. Soft tissue dissection involves the transection of the rectococcygeus and levator ani muscles to allow exposure of the caudal portion of the rectum.[1,2,6] Advantages of this approach include good surgical exposure of the caudal and dorsal portions of the rectum and visibility of the pudendal nerve and pelvic plexus, which are essential for the maintenance of fecal continence.[1,6] A disadvantage of the procedure is the inability to assess the abdomen for metastatic lesions. In a retrospective case series[6] of 13 dogs that underwent rectal resection by means of a dorsal inverted-U approach, postoperative complications included transient tenesmus (n = 12), transient hematochezia (3), and anastomotic dehiscence (4); fecal incontinence was observed in all dogs that had > 6 cm of rectum resected (4), and this had not resolved by the end of the 10-week follow-up period.

The pull-out technique involves the use of stay sutures to evert the rectal mucosa to the level of the mass and excision of the mass with a submucosal resection technique, thoracoabdominal stapler, or rectal amputation and anastamosis.[3,11] The primary advantage of this procedure is that minimal surgical dissection results in a low risk for postoperative complications. In a retrospective case series[3] of 23 dogs with rectal masses excised with the pull-out technique, 9 dogs developed hematochezia and mild tenesmus, which resolved within 7 days, and 1 dog had partial dehiscence, which healed by second intention and required no further intervention. A disadvantage is that the limited surgical exposure makes achieving clean surgical margins difficult. Consequently, this approach is recommended primarily for benign diseases confined to the mucosa of the distal portion of the rectum.

Transanal endoscopic resection involves the piecemeal removal of a mass with a cauterized endoscopic loop and has been recommended for the treatment of benign rectal tumors.[10,13] Because of the piecemeal nature of this technique, complete excision is difficult to achieve for both benign and malignant tumors. Furthermore, there is a high risk of rectal perforation because the depth of resection with the endoscopic loop cannot be determined intraoperatively. In a retrospective case series[6] of 13 dogs with rectal neoplasia treated with transanal endoscopic resection, complete excision of the tumor was achieved in 3 dogs, 5 dogs had incomplete excision of the tumor with clinical improvement, and 5 dogs died or were euthanized subsequent to rectal perforation or poor response to treatment. Caution should be used when considering this approach owing to the high incidence of complications and because it is only indicated for benign tumors, which are often misdiagnosed on the basis of histologic examination of specimens obtained by endoscopic biopsy; in dogs, 30% to 36% rectal masses that were initially diagnosed as benign lesions by histologic examination of endoscopic biopsy specimens were subsequently definitively determined to be malignant on the basis of histologic examination of the excised masses.[5,14]

The transanal RPT procedure involves an incision around the anocutaneous junction or another area of the distal portion of the rectum and dissection of the external rectal attachments, which allows the isolated rectum to be pulled caudally.[2,12] This approach is commonly confused with the pull-out technique or rectal eversion. The major difference between the 2 procedures is that the rectal eversion technique does not involve dissection of the external rectal attachments. Depending on the extent of disease, the RPT procedure can be performed alone or in conjunction with a celiotomy. The combined RPT procedure and celiotomy is time-consuming, requires 2 surgical approaches, and has a high complication rate.[5,11] Advantages of the RPT procedure include good visibility of lesions involving the mid to caudal portions of the rectum and the ability to excise lesions that involve the anocutaneous junction. The RPT procedure requires less soft tissue dissection, compared with that required for the ventral and dorsal approaches, and offers better surgical exposure of the rectal mass than do the rectal eversion and transanal endoscopic procedures. Disadvantages of the RPT procedure include the inability to assess the abdomen for metastatic lesions and the high risk for postoperative complications, especially fecal incontinence.[4,5,11] To our knowledge, only 3 small retrospective case series studies[4,5,15] that involved a total of 24 dogs have been performed to evaluate the RPT procedure for treatment of dogs with rectal masses. Postsurgical complications included fecal incontinence (18% to 40%), tenesmus (70% to 100%), and rectal bleeding (40% to 100%).[4,5,15] Although all those complications were self-limiting in 1 study,[5] 2 of 8 dogs developed permanent complications in 1 study,[4] and 1 of 3 dogs developed persistent fecal incontinence and was subsequently euthanized in the other study.[15] The primary objective of the study reported here was to evaluate the incidence of postoperative complications associated with the RPT procedure in a large population of dogs. A secondary objective was to evaluate the long-term outcomes for dogs with various rectal masses that were surgically excised by means of an RPT procedure.

## Materials and Methods

**Case selection—**The medical record databases from Alta Vista Animal Hospital, Ottawa, ON, Canada; Med-Vet Medical and Cancer Centers for Pets, Fairfax, Ohio; Veterinary Specialist Services, Carrera, QLD, Australia; Clinica Veterinaria Tibaldi, Milan, Italy; Veterinary Emergency and Specialty Hospital, South Deerfield, Mass; and the veterinary medical teaching hospitals of the University

of California-Davis, Universita' degli Studi di Torino, Kansas State University, Colorado State University, University of Guelph, and Auburn University were reviewed for dogs with rectal diseases that underwent a transanal RPT procedure between January 1, 2000, and September 30, 2013. Dogs were included in the study regardless of whether they had a partial (ie, < 360° of the rectal circumference transected) or complete (ie, transection of the entire rectal circumference) RPT procedure performed.

**Medical records review—**For each dog enrolled in the study, data extracted from the medical record included signalment; body weight; history; results of physical examination, CBC, serum biochemical analysis, and urinalysis; location of the mass; clinical staging results as determined by thoracic and abdominal radiography, abdominal ultrasonography, CT, or colonoscopy when available; details about the surgical technique used (complete or partial RPT surgery, length [cm] of rectum resected, length [cm] of the distal portion of the rectum that was preserved, and whether an anal sacculectomy was performed); histologic diagnosis for the excised mass and the extent of the completeness of mass excision; postoperative complications and duration of those complications; adjuvant chemotherapy when used; whether there was local recurrence or metastasis of rectal tumors; and survival time. Postoperative complications were defined as transient if they resolved and permanent if they persisted until death or termination of the study. In an attempt to adjust the length of rectum resected for dog size, a ratio of body weight to length of rectum resected was calculated for each dog.

**RPT surgical procedures—**Dogs that had a complete RPT surgery performed were positioned in sternal recumbency, and the surgical site was aseptically prepared. An incision was made at the anocutaneous junction or proximal to the anocutaneous junction such that a cuff of the distal portion of the distal rectum was preserved. The anal sacs were removed only if the anal sac ducts were included in the excision. Stay sutures were placed around the circumference of the rectum either before or as the incision was made. The stay sutures were used to apply caudal retraction to the rectum, and a combination of blunt and sharp dissection as close to the rectal wall as possible was used to mobilize the rectum. The dissection was continued until the rectal mass was completely visible with adequate margins for excision as determined by the primary surgeon. In some instances, the rectum was opened longitudinally proximal to the mass before it was excised to confirm the cranial margins of the mass. Stay sutures were placed in the rectum proximal to the proposed resection site to prevent its retraction during mass excision. Then the mass was excised and a rectal-to-rectal or rectocutaneous anastomosis procedure was performed. The anastomosis was performed following complete resection of the mass and distal portion of the rectum or by progressively excising and suturing a portion of the circumference of the rectum and then excising and suturing the remaining circumference of the rectum. The anastomosis was closed in 1 or 2 layers.

The surgical procedure for dogs that had a partial RPT surgery performed was similar to that for dogs that had a complete RPT surgery performed except that the initial incision at the anocutaneous junction was extended only as far as necessary around the circumference of the anus to complete the procedure. The remainder of the procedure was completed as described.[2,12]

**Statistical analysis—**Outcomes of interest for each dog included diagnosis, complications, time to local recurrence, time to metastasis, and survival time. All times were calculated from the date of surgery to the event (local recurrence, metastasis, or death) or when lost to follow-up. The cause of death was classified as either related or unrelated to the disease. Disease-related deaths were further classified as associated either with surgical complications (eg, dehiscence or infection) or with disease (eg, metastasis). For dogs with medical records with incomplete outcome information, referring veterinarians or owners were contacted in an attempt to obtain that information.

The distributions for continuous data were graphically assessed for normality. The mean ± SD and range were provided for data with normal distributions, and the median and range were provided for data with nonnormal distributions. Categorical data were presented as frequencies and percentages.

Univariable logistic regression was used to assess the respective associations of surgical technique used (complete [360°] or partial [< 360°] RPT surgery), length of rectum resected, ratio of body weight to length of rectum resected, anocutaneous junction resection, anal sacculectomy, and various postsurgical complications with each of the following outcomes: fecal incontinence (both transient and permanent), permanent fecal incontinence, diarrhea, tenesmus, rectal bleeding, and constipation. In instances when there was quasiseparation of the data, those associations were assessed with Firth logistic regression by use of the Firth bias correction. Odds ratios and 95% CIs were calculated for each independent variable.

For survival analysis, dogs were categorized as having non–tumor-related or tumor-related disease on the basis of the histologic diagnosis of their rectal masses, and dogs in the tumor-related disease group were subdivided on the basis of tumor type, whether they had benign or malignant disease, and whether the tumor was completely or incompletely excised as determined by histologic evaluation. The overall survival time was calculated as the time from surgery until death regardless of cause (this endpoint was chosen because dogs with various diseases, some of which were benign and some of which were malignant, were included in the study). Kaplan-Meier methodology was used to generate survival curves and calculate MSTs. Log rank tests were used to compare survival distributions between the dogs with and without tumor-related disease; among dogs with non–tumor-related disease, dogs with benign disease, and dogs with malignant disease; between dogs with benign disease and dogs with malignant disease; between dogs with rectal carcinoma and dogs with rectal carcinoma in situ; and between dogs with incomplete tumor excision and dogs with complete tumor excision.

Univariable and multivariable Cox proportional hazards analyses were used to assess the association of

age, sex, various tumor properties (maximum diameter and type [malignant or benign]), surgical technique (complete or partial RPT surgery), extent of tumor excision (incomplete or complete), and postoperative complications (presence of transient or permanent fecal incontinence, dehiscence, and infection and the number of complications that developed) with the overall survival time. Hazard ratios and 95% CIs were calculated for each independent variable. All analyses were performed with commercially available software,[a,b] and values of $P < 0.05$ were considered significant.

## Results

**Animals**—Seventy-four dogs (23 spayed females, 4 sexually intact females, 33 castrated males, and 14 sexually intact males) with rectal diseases underwent RPT surgery at the participating institutions between January 1, 2000, and September 30, 2013, and were enrolled in the study. The mean ± SD age at the time of initial evaluation for the study dogs was 9.0 ± 2.8 years (range, 3 to 15 years), and the mean ± SD body weight was 21.4 ± 12.2 kg (47.1 ± 26.8 lb; range, 3.5 to 48.0 kg [7.7 to 105.6 lb]). A variety of breeds were represented, including mixed-breed dog (n = 19); West Highland White Terrier (4); Golden Retriever, pit bull–type dog, Beagle, Shetland Sheepdog, and Husky (3 each); Pug, Poodle, Labrador Retriever, Australian Shepherd, Italian Hound, Welsh Pembroke Corgi, Weimaraner, and Dachshund (2 each); and Great Pyrenees, Catahoula, Lhasa Apso, English Springer Spaniel, Akita, Rottweiler, Shih Tzu, Bassett Hound, Cocker Spaniel, Scottish Terrier, Chihuahua, Yorkshire Terrier, German Hound, Pomeranian, Maremma Sheepdog, Jack Russell Terrier, Giant Schnauzer, Australian Cattle Dog, Great Dane, and German Shepherd Dog (1 each).

**Presurgical clinical findings**—The dogs most frequently had a history of hematochezia (48/74 [64.9%]), tenesmus (25/74 [33.8%]), constipation (21/74 [28.4%]), diarrhea (15/74 [20.3%]), and a perianal mass noted by the owner or referring veterinarian (13/74 [17.6%]). Some dogs also had a history of rectal prolapse (4/74 [5.4%]), flattened stool (3/74 [4.1%]), perianal fistula development after anal sacculectomy (3/74 [4.1%]), and excessive licking of the perineal area (2/74 [2.7%]). Fifteen (20.3%) dogs had a history of a rectal mass removal.

A rectal tumor was identified during initial physical examination in 57 of 74 (77.0%) dogs. The maximum tumor diameter was recorded for 40 of 57 (70.2%) dogs, and the median maximum tumor diameter was 2.5 cm (range, 0.5 to 10.0 cm). Of the 57 tumors, 45 (78.9%) were malignant with a median maximum tumor diameter of 2.5 cm (range, 0.5 to 10.0 cm), and 12 (21.1%) were benign with a median maximum tumor diameter of 3.0 cm (range, 1.0 to 5.0 cm).

Results of CBCs, serum biochemical analyses, and urinalyses were nonspecific. Three-view thoracic radiographs were obtained in 62 dogs prior to surgery, and abdominal radiographs were obtained in 12 dogs. No metastatic lesions were identified on thoracic or abdominal radiographs. Constipation was seen in 8 dogs on abdominal radiographs. Abdominal ultrasonography was performed for 53 dogs, and 15 of those dogs had evidence of lymphadenomegaly. Ultrasound-guided fine-needle aspiration of enlarged lymph nodes was performed in 5 dogs, and cytologic evaluation of those aspirates revealed metastatic disease in 4 of those dogs (3 dogs with rectal carcinoma and 1 dog with a rectal MCT). Of the 45 dogs with malignant tumors, 40 had complete staging (thoracic radiography and abdominal ultrasonography) performed. Of the remaining 5 dogs with malignant tumors, 1 with a rectal carcinoma did not have thoracic radiography or abdominal ultrasonography performed, 1 with a rectal carcinoma did not have thoracic radiography performed, and 3 dogs (1 each with rectal carcinoma, anaplastic rectal tumor, and rectal carcinoma in situ) did not have abdominal ultrasonography performed. Abdominal CT was performed in 2 dogs, and metastatic lesions were not identified in either dog. Colonoscopy was performed in 21 dogs, and the results helped to characterize the number and extent of rectal masses and identify strictures.

Fine-needle aspiration of rectal masses was performed for 5 of the 57 (8.8%) dogs with rectal tumors. Cytologic results of those aspirates were consistent with the definitive diagnosis for 4 dogs (rectal MCT [n = 2], plasmacytoma [1], and carcinoma [1]) and were nondiagnostic in 1 dog. Rectal biopsies were performed for 17 of the 57 (29.8%) dogs with rectal tumors. Eight biopsies were performed endoscopically, and the histologic evaluation of the biopsy specimen was consistent with the definitive diagnosis in 5 dogs (rectal carcinoma), yielded an incorrect diagnosis for 2 dogs (rectal carcinoma in situ), and was nondiagnostic in 1 dog (rectal carcinoma). A core or excisional biopsy was performed for the other 9 dogs, and histologic evaluation of those biopsy specimens was consistent with the definitive diagnosis in 8 dogs (rectal carcinoma [n = 6], plasmacytoma [1], and polyp [1]) and yielded an incorrect diagnosis for 1 dog with a rectal carcinoma.

**Surgical results**—A partial (< 360° of the rectal circumference transected) RPT procedure was performed in 11 (14.9%) dogs, and a complete (entire circumference of rectum transected) RPT procedure was performed in 63 (85.1%) dogs. For dogs that had a partial RPT procedure performed, the portion of the rectal circumference that was transected was 90° in 1, 120° in 1, 180° in 7, and 270° in 2; 5 dogs had malignant tumors, 3 dogs had benign tumors, and 3 dogs had non–tumor-related disease (rectocutaneous fistula [n = 2] and ulcerative proctitis [1]). For the 63 dogs that had a complete RPT performed, 40 had malignant tumors, 9 had benign tumors, and 14 had non–tumor-related disease. Anal sacculectomy was performed concurrently with the RPT surgery for 19 (25.7%) dogs (14 dogs with malignant tumors, 2 dogs with benign tumors, and 3 dogs with non–tumor-related disease).

The length of rectum resected was recorded in 45 of 74 (60.8%) dogs (35 dogs with rectal tumors [27 with malignant tumors and 8 with benign tumors] and 10 dogs with non–tumor-related disease). The mean ± SD length of rectum resected was 6.3 ± 3.3 cm (range, 0.5 to 14.0 cm). The mean length of rectum resected for dogs with tumors, malignant tumors, benign tumors,

and non–tumor-related disease was 6.3, 6.8, 4.6, and 6.2 cm, respectively. The mean ± SD length of rectum resected for dogs in which the anocutaneous junction was resected (4.32 ± 3.2 cm) was significantly ($P$ = 0.003) shorter than that for dogs in which the anocutaneous junction was preserved (7.2 ± 2.6 cm). The median ratio of body weight to length of rectum resected was 2.8 kg/cm (6.16 lb/cm) for all 45 dogs, 2.8 kg/cm for the 35 dogs with tumors, 2.8 kg/cm for the 27 dogs with malignant tumors, 3.8 kg/cm (8.36 lb/cm) for the 8 dogs with benign tumors, and 2.7 kg/cm (5.94 lb/cm) for dogs with non–tumor-related disease.

The length of the distal portion of the rectum that was preserved was recorded for 63 dogs. The anocutaneous junction was resected in 31 (49.2%) dogs (21 dogs with malignant tumors, 6 dogs with benign tumors, and 4 dogs with non–tumor-related disease), whereas a cuff of the distal portion of the rectum was preserved in 32 (50.8%) dogs (20 dogs with malignant tumors, 5 dogs with benign tumors, and 7 dogs with non–tumor-related disease). The mean ± SD length of the distal portion of the rectum preserved was 1.8 ± 1.3 cm (range, 0.3 to 6.0 cm).

**Postoperative complications—**Of the 74 dogs, 16 (21.6%) did not develop postoperative complications, whereas 58 (78.4%) developed at least 1 postoperative complication. Sixteen (27.6%) dogs developed a single complication, 19 (32.8%) dogs developed 2 complications, 15 (25.9%) dogs developed 3 complications, 5 (8.6%) dogs developed 4 complications, and 3 (5.2%) dogs developed 5 complications. Five dogs were lost to follow-up within 189 days after surgery, of which 3 had no complications (lost to follow-up at 3, 8, and 9 days) and 2 had transient complications that had resolved prior to being lost to follow-up at 20 and 34 days.

Fecal incontinence was the most common complication and was observed in 42 of 74 (56.8%) dogs, of which the fecal incontinence was transient in 19 (45.2%) and permanent in 23 (54.8%). The median duration of fecal incontinence was 14 days (range, 3 to 180 days) for transiently affected dogs. Of the 23 dogs classified with permanent fecal incontinence, 1 dog was euthanized 3 days after RPT surgery (and hence met the criteria for permanent fecal incontinence), 12 dogs died < 180 days after RPT surgery, and 1 dog was still alive 32 days after RPT surgery but was subsequently lost to follow-up, and the remaining 9 dogs were still alive at the end of the observation period. The only variable significantly associated with fecal incontinence was the surgical technique used; dogs that underwent a complete RPT surgery were significantly ($P$ = 0.007) more likely to develop fecal incontinence than were dogs that underwent a partial RPT surgery (OR, 18.63; 95% CI, 2.24 to 155.24; **Table 1**). Dogs that underwent a complete RPT surgery were 13.35 (95% CI, 0.66 to 268.75) times as likely to develop permanent fecal incontinence, compared with dogs that underwent a partial RPT surgery; however, that association was not significant ($P$ = 0.09). In fact, permanent fecal incontinence was not significantly associated with any of the variables assessed. For dogs that did (n = 29) and did not (16) develop fecal incontinence (both transient and permanent incontinence), the mean ± SD length of rectum resected was 6.7 ± 3.3 cm and 5.5 ± 3.3 cm, respectively, and the mean ± SD ratio of body weight to length of rectum resected was 7.7 ± 16.8 kg/cm (16.94 ± 36.52 lb/cm) and 7.4 ± 5.9 kg/cm (16.28 ± 12.98 lb/cm), respectively. For dogs that did (n = 12) and did not (33) develop permanent fecal incontinence, the mean ± SD length of rectum resected was 7.6 ± 2.0 cm and 5.8 ± 3.6 cm, respectively, and the mean ± SD ratio of body weight to length of rectum resected was 2.1 ± 1.3 kg/cm (4.62 ± 2.86 lb/cm) and 9.6 ± 15.7 kg/cm (21.12 ± 34.54 lb/cm).

Other complications included diarrhea (n = 32 [55.2%] dogs), tenesmus (23 [39.7%]), stricture formation (16 [27.6%]), rectal bleeding (8 [13.8%]), constipation (7 [12.1%]), dehiscence (6 [10.3%]), and infection (4 [6.9%]). For the 32 dogs that developed diarrhea, the duration of the condition was not reported for 7 (21.9%), was transient for 17 (53.1%) with a median duration of 14 days (range, 1 to 90 days), and was permanent for 8 (25.0%). All 8 dogs with permanent diarrhea were affected for > 14 days, although 4 of those dogs died within 90 days after the RPT surgery and 1 dog was alive at 32 days after RPT surgery but was subsequently lost to follow-up. Postoperative diarrhea was significantly associated

Table 1—Results of univariable logistic regression analyses to identify variables associated with the development of fecal incontinence (both transient and permanent; n = 42 dogs) and permanent fecal incontinence (23) following RPT surgery in a retrospective study of 74 dogs with rectal masses.

| | Outcome | | | |
|---|---|---|---|---|
| | Transient and permanent fecal incontinence | | Permanent fecal incontinence | |
| Variable | OR (95% CI) | *P* value | OR (95% CI) | *P* value |
| Surgical technique used (complete [360°] vs partial [< 360°] RPT surgery) | 18.63 (2.24–155.24) | 0.007 | 13.35 (0.66–268.75) | 0.09 |
| Length of rectum resected*† | 1.12 (0.92–1.36) | 0.24 | 1.2 (0.96–1.50) | 0.11 |
| Body weight-to-length of rectum resected ratio*‡ | 1.00 (0.96–1.05) | 0.95 | 0.65 (0.40–1.06) | 0.09 |
| Anocutaneous junction resected | 0.56 (0.21–1.54) | 0.26 | 0.58 (0.20–1.70) | 0.32 |
| Concurrent anal sacculectomy performed | 1.43 (0.49–4.18) | 0.52 | 0.73 (0.23–2.36) | 0.60 |

Values of $P < 0.05$ were considered significant.

*Information available for only 45 dogs (29 incontinent [12 permanent and 17 transient] and 16 continent). †The OR was calculated on the basis of each 1-cm increase in the length of rectum resected. ‡The OR was calculated on the basis of each 1-kg/cm (2.2-lb/cm) increase in the body weight-to-length of rectum resected ratio.

with the length of rectum resected (OR, 1.31; 95% CI, 1.05 to 1.64; $P = 0.02$; **Table 2**), ratio of body weight to length of rectum resected (OR, 0.77; 95% CI, 0.160 to 0.99; $P = 0.04$), and fecal incontinence (OR, 9.72; 95% CI, 3.10 to 30.51; $P < 0.001$). The mean ± SD length of rectum resected for dogs with diarrhea was 7.7 ± 2.6 cm (median, 2.5 cm), whereas that for dogs without diarrhea was 5.2 ± 3.4 cm (median, 5.8 cm).

Of the 23 dogs that developed tenesmus, the duration of the condition was not reported for 8 (34.8%), was transient for 10 (43.5%) with a median duration of 29 days (range, 3 to 150 days), and was permanent for 5 (21.7%). The 5 dogs with permanent tenesmus were affected for 726, 897, 1,088, 1,558, and 1,812 days. Resection of the anocutaneous junction (OR, 0.19; 95% CI, 0.05 to 0.74; $P = 0.02$; Table 2) and concurrent anal sacculectomy (OR, 0.20; 95% CI, 0.04 to 0.97; $P = 0.046$) were associated with a significantly decreased risk of postoperative tenesmus, whereas constipation (OR, 45.92; 95% CI, 2.05 to > 999.99; $P = 0.02$) and stricture formation (OR, 5.08; 95% CI, 1.52 to 16.93; $P = 0.08$) were associated with a significantly increased risk of postoperative tenesmus.

Rectal bleeding was transient or intermittent in all 8 affected dogs. Tenesmus was the only postoperative complication significantly ($P = 0.01$) associated with rectal bleeding (OR, 8.5; 95% CI, 1.56 to 46.05; Table 2).

For the 7 dogs with constipation, the duration of the condition was not recorded for 2, was transient for 3 with a median duration of 3 days (range, 3 to 30 days), and was permanent for 2. One of the dogs with permanent constipation was lost to follow-up at 897 days after surgery, and the other dog was alive at 1,088 days after surgery. Postoperative constipation was significantly associated with stricture formation (OR, 9.71; 95% CI, 1.50 to 55.94; $P = 0.02$; Table 2) and tenesmus (OR, 45.92; 95% CI, 2.41 to 875.78; $P = 0.01$).

Sixteen of the 58 (27.6%) dogs with postoperative complications developed rectal strictures, which resolved in 10 dogs following various treatments that included steroid administration and balloon dilation of the strictured area. The rectal stricture did not resolve in 1 dog, and the outcome was not reported in the remaining 5 dogs.

Of the 6 dogs with dehiscence, 1 dog developed septic peritonitis, 3 dogs developed pararectal abscesses, and 2 dogs had mild incisional dehiscence that healed by second intention. The dog with septic peritonitis was euthanized, and in the remaining 3 dogs, the pararectal abscesses resolved with surgical and medical management.

**Rectal mass characterization—**The 57 tumors identified included rectal carcinoma (n = 31 [54.4%]); rectal carcinoma in situ (7 [12.3%]); rectal polyp (6 [10.5%]); hepatoid perianal adenoma (3 [5.3%]); leiomyoma, rectal MCT, and perianal squamous cell carcinoma (2 [3.5%] each); and apocrine gland anal sac adenocarcinoma, rectal plasmacytoma, rectal lymphoma, and rectal anaplastic tumor (1 [1.8%] each). The completeness of mass excision as determined by histologic evaluation of margins was recorded for 51 of the 57 dogs with tumors. Excision was complete for 33 dogs (8 with benign tumors and 25 with malignant tumors) and incomplete for 18 dogs (2 with benign tumors and 16 with malignant tumors). Of the 17 dogs with non–tumor-related disease, 7 had colitis or proctitis, 4 had persistent rectal dilation following a previous perineal herniorrhaphy, 3 had rectocutaneous fistulae, and 1 each had rectal trauma, rectal stenosis, and a rectal tear subsequent to anal sacculectomy.

**Postsurgical treatment and outcome—**Adjuvant chemotherapy was administered to 9 dogs. One dog with rectal lymphoma was treated with a modified University of Wisconsin-Madison chemotherapy protocol (UW-25).[16] One dog with multiple rectal plasmacytomas was treated with melphalan and prednisone. One dog with a rectal MCT was treated with vinblastine,

Table 2—Results of univariable logistic regression analyses to assess the respective associations of various variables with the development of diarrhea, tenesmus, rectal bleeding, and constipation following RPT surgery in a retrospective study of 74 dogs with rectal masses.

| | Outcome | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Diarrhea | | Tenesmus | | Rectal bleeding | | Constipation | |
| Variable | OR (95% CI) | *P* value | OR (95% CI) | *P* value | OR (95% CI) | *P* value | OR (95% CI) | *P* value |
| Surgical technique used (complete [360°] vs partial [< 360°] RPT surgery) | 4.09 (0.82 to 20.46) | 0.09 | 13.69 (0.68 to 275.69) | 0.09 | 1.25 (0.14 to 11.29) | 0.84 | 3.06 (0.14 to 64.90) | 0.47 |
| Length of rectum resected*† | 1.31 (1.05 to 1.64) | 0.02 | 1.15 (0.94 to 1.42) | 0.18 | 0.94 (0.66 to 1.35) | 0.74 | 1.10 (0.83 to 1.47) | 0.50 |
| Body weight-to-length of rectum resected ratio*‡ | 0.77 (0.60 to 0.99) | 0.04 | 0.82 (0.65 to 1.04) | 0.10 | 0.99 (0.88 to 1.11) | 0.84 | 0.92 (0.74 to 1.16) | 0.48 |
| Anocutaneous junction resected | 0.81 (0.30 to 2.22) | 0.16 | 0.19 (0.05 to 0.74) | 0.02 | 0.67 (0.10 to 4.29) | 0.67 | 0.48 (0.08 to 2.85) | 0.42 |
| Concurrent anal sacculectomy performed | 1.25 (0.44 to 3.57) | 0.67 | 0.20 (0.04 to 0.97) | 0.046 | 0.38 (0.04 to 3.32) | 0.38 | 0.45 (0.05 to 4.03) | 0.48 |
| Fecal incontinence | 9.72 (3.10 to 30.51) | < 0.001 | 1.33 (0.49 to 3.62) | 0.58 | 0.74 (0.17 to 3.20) | 0.68 | — | — |
| Diarrhea | — | — | 1.06 (0.39 to 2.88) | 0.91 | 0.77 (0.17 to 3.47) | 0.73 | — | — |
| Rectal bleeding | 0.77 (0.17 to 3.47) | 0.73 | — | — | — | — | — | — |
| Constipation | — | — | 45.92 (2.05 to > 999.99) | 0.02 | 1.43 (0.15 to 13.65) | 0.76 | — | — |
| Dehiscence | 1.35 (0.25 to 7.15) | 0.73 | 0.41 (0.05 to 3.72) | 0.43 | 0.55 (0.02 to 12.30) | 0.71 | 0.63 (0.03 to 15.46) | 0.78 |
| Infection | 0.42 (0.04 to 4.23) | 0.46 | 0.22 (0.01 to 5.99) | 0.37 | 0.82 (0.03 to 23.18) | 0.91 | 0.94 (0.03 to 26.93) | 0.97 |
| Stricture | 1.38 (0.45 to 4.18) | 0.57 | 5.08 (1.52 to 16.93) | 0.008 | 1.21 (0.22 to 6.69) | 0.82 | 9.17 (1.50 to 55.94) | 0.02 |
| Tenesmus | 1.06 (0.39 to 2.88) | 0.91 | — | — | 8.50 (1.56 to 46.05) | 0.01 | 45.92 (2.41 to 875.78) | 0.01 |

Thirty-two dogs developed diarrhea, 23 dogs developed tenesmus, 8 dogs developed rectal bleeding, and 7 dogs developed constipation.
*See* Table 1 for remainder of key.

cyclophosphamide, and prednisone. One dog with an anaplastic rectal tumor was treated with toceranib. Five dogs with rectal carcinomas were treated as follows: 2 dogs were treated with NSAIDs (deracoxib or piroxicam); 1 dog was treated with cyclophosphamide and deracoxib, which was discontinued after 2 months because of the development of sterile hemorrhagic cystitis; 1 dog was treated with 1 dose of carboplatin followed by toceranib; and 1 dog was treated with mitoxantrone for concurrent urinary bladder transitional cell carcinoma. For several of these dogs, the doses of the drugs administered were not provided in the medical records.

Information about the recurrence of the rectal mass was available for 73 dogs. The rectal mass recurred in 10 (13.7%) dogs (6 dogs with rectal carcinoma and 1 dog each with rectal plasmacytoma, apocrine gland anal sac adenocarcinoma, rectal MCT, and proctitis). Of those 10 dogs, excision of the primary mass as determined by histologic evaluation of resection margins was complete for 4, incomplete for 5, and not reported for the dog with proctitis because it did not have a neoplastic condition. The median time to mass recurrence for all 10 dogs was 258 days (range, 35 to 532 days). The median time to mass recurrence for dogs with rectal carcinoma was 417 days (range, 116 to 532 days). The time to mass recurrence was 33 days for the dog with multiple rectal plasmacytomas, 68 days for the dog with rectal MCT, 356 days for the dog with apocrine gland anal sac adenocarcinoma, and 54 days for the dog with proctitis. Local recurrence of the rectal mass was not significantly associated with incomplete excision of the mass (OR, 2.94; 95% CI, 0.60 to 15.38; $P = 0.18$) or malignancy status of the tumor (OR, 2.38; 95% CI, 0.27 to 21.15; $P = 0.44$).

Information about metastatic lesions was available for 72 dogs. Metastatic lesions were confirmed in 10 (13.9%) dogs. Three dogs had metastatic lesions prior to surgery, 1 dog had metastatic lesions identified prior to and after surgery, and 6 dogs developed metastatic lesions after surgery. On the basis of preoperative abdominal ultrasonographic results, 15 dogs had evidence of sublumbar lymphadenomegaly and were suspected of having metastatic lesions. Cytologic evaluation of ultrasound-guided fine-needle aspirates obtained from the enlarged sublumbar lymph nodes subsequently confirmed metastasis in 1 dog with a rectal MCT and 3 dogs with rectal carcinomas. The remaining 11 dogs with sublumbar lymphadenomegaly were subsequently determined to have proctitis (n = 1), periorchitis (1), rectal polyp (1), rectal lymphoma (1), rectal plasmacytoma (1), rectal MCT (1), and rectal carcinoma (5). Of those 11 dogs, only 1 had a fine-needle aspirate obtained from the sublumbar lymph node prior to surgery, and the cytologic results for that aspirate were consistent with a reactive lymph node. For the 7 dogs that had metastasis diagnosed after surgery (rectal carcinoma [n = 4], rectal lymphoma [1], rectal MCT [1], and apocrine gland adenocarcinoma [1]), metastatic lesions were identified in the sublumbar lymph nodes (6) and sublumbar lymph nodes and lungs (1), and 4 of those dogs were suspected but not confirmed to have metastatic lesions in the sublumbar lymph nodes prior to surgery. A dog with a rectal MCT had nodal metastasis prior to surgery and subsequently developed further metastatic lesions in the remaining sublumbar lymph node 68 days after RPT surgery. Of the 31 dogs with rectal carcinoma, 7 (22.6%) were diagnosed with metastatic disease and 4 (12.9%) developed metastatic lesions after RPT surgery. The median time to metastasis was 356 days (range, 20 to 659 days) for all affected dogs. The median time to metastasis for 7 dogs with rectal carcinoma was 529 days (range, 159 to 659 days). The time to metastasis was 20 days for a dog with rectal lymphoma, 68 days for a dog with rectal MCT, and 356 days for a dog with apocrine gland anal sac adenocarcinoma.

At the end of the study observation period, 32 dogs were dead, 23 were alive, and 19 were lost to follow-up. The cause of death was unrelated to rectal disease for 12 (37.5%) dogs and related to rectal disease for 20 (62.5%) dogs, of which 13 died because of the disease and 7 were euthanized because of surgical complications. Of the 23 dogs that were still alive at the end of the observation period, 22 were free of rectal disease, and 1 dog with rectal lymphoma was alive 1,070 days after surgery despite the identification of metastatic lesions in a sublumbar lymph node 20 days after surgery. Of the 19 dogs lost to follow-up, 1 dog with rectal carcinoma had recurrence of the rectal mass 365 days after RPT surgery and was lost to follow-up at 415 days after

Table 3—Results of univariable Cox proportional hazards analyses to assess the respective associations of various variables with survival time following RPT surgery in a retrospective study of 74 dogs with rectal masses.

| Variable | Hazard ratio (95% CI) | *P* value |
|---|---|---|
| Age* | 1.12 (0.98–1.28) | 0.09 |
| Sex | | |
| Sexually intact female | 9.45 (2.72–32.87) | < 0.001 |
| Spayed female | 1.39 (0.59–3.29) | 0.45 |
| Sexually intact male | 1.22 (0.46–3.24) | 0.68 |
| Neutered male | Referent | — |
| Maximum tumor diameter† | 1.24 (0.98–1.57) | 0.07 |
| Tumor-related disease vs non–tumor-related disease | 1.68 (0.69–4.11) | 0.25 |
| Malignant tumor vs benign tumor | 1.62 (0.61–4.35) | 0.34 |
| Incomplete vs complete excision of rectal mass as determined by histologic evaluation | 2.77 (1.18–6.52) | 0.02 |
| Presence of fecal incontinence (transient and permanent) | 1.67 (0.81–3.45) | 0.17 |
| Presence of permanent incontinence | 3.35 (1.62–6.93) | 0.001 |
| Presence of dehiscence | 3.85 (1.33–11.17) | 0.01 |
| Presence of infection | 5.10 (1.15–22.35) | 0.03 |
| Number of postsurgical complications | | |
| 0 | Referent | — |
| 1 | 1.43 (0.45–4.53) | 0.54 |
| 2 | 3.13 (1.05–9.30) | 0.04 |
| 3 | 1.31 (0.40–4.29) | 0.66 |
| 4 | 1.90 (0.36–10.10) | 0.45 |
| 5 | 1.06 (0.12–9.24) | 0.96 |
| Presence of permanent complications | 2.63 (1.31–5.30) | 0.007 |

Postoperative complications were defined as transient if they resolved and permanent if they persisted until death or termination of the study.

*Hazard ratio was calculated on the basis of each 1-year increase in age. †Information available for only 40 of 57 dogs with tumors, and the hazard ratio was calculated on the basis of each 1-cm increase in diameter.

— = Not applicable.

*See* Table 1 for remainder of key.

surgery, another dog with rectal carcinoma and metastatic lesions in the sublumbar lymph nodes at the time of surgery was lost to follow-up 9 days after surgery, and the remaining 17 dogs were free of rectal disease at the time they were lost to follow-up (range, 3 to 2,331 days). Survival times were recorded for 73 dogs. The overall MST was 1,150 days (range, 1 to 2,331 days). The MST was 1,641 days (range, 3 to 2,015 days) for 17 dogs with non–tumor-related disease, 935 days (range, 1 to 2,331 days) for 56 dogs with tumor-related disease, 1,558 days (range, 5 to 1,851 days) for 11 dogs with benign tumors, and 726 days (range, 1 to 2,331 days) for 45 dogs with malignant tumors. The MST was 696 days (range, 1 to 2,018 days) for 31 dogs with rectal carcinoma and 1,006 days (range, 31 to 2,331 days) for 7 dogs with rectal carcinoma in situ. The MST did not differ significantly ($P = 0.33$) between dogs with benign tumors and those with malignant tumors.

Several variables were assessed for association with overall survival time, and the negative prognostic factors for survival time as determined by univariable Cox proportional hazard analysis were summarized (**Table 3**). Results of the multivariable Cox proportional hazard analysis indicated that when sex, neutered status, and the presence of permanent complications, dehiscence, and infection were controlled, the hazard of death for dogs in which the rectal mass was incompletely excised was significantly ($P = 0.02$) greater than that for dogs in which the rectal mass was completely excised (hazard ratio, 4.38; 95% CI, 1.48 to 12.92).

## Discussion

Results of 3 previous case series[4,5,15] involving a total of 24 dogs indicate that the most commonly identified complications following RPT surgery are tenesmus (70% to 100%), rectal bleeding (40% to 100%), and fecal incontinence (18% to 40%). However, in the present study, fecal incontinence (42/74 [56.8%]) was the complication most frequently recorded for dogs after RPT surgery, followed by diarrhea (32/74 [43.2%]), tenesmus (23/74 [31.1%]), stricture formation (16/74 [21.6%]), rectal bleeding (8/74 [10.8%]), constipation (7/74 [9.5%]), dehiscence (6/74 [8.1%]), and infection (4/74 [5.4%]). The incidence of dogs that developed permanent fecal incontinence (23/74 [31.3%]) after RPT surgery in the present study was consistent with that of previous studies (0% to 33%).[4,5,15]

Fecal continence has 2 major components, sphincteric continence and reservoir continence.[4,6,17] Sphincteric continence involves the ability to contract the external anal sphincter to resist peristalsis in the rectum and colon. Reservoir continence involves the ability of the descending colon to expand and store fecal matter until an appropriate time for elimination. In dogs, the external anal sphincter is innervated by the caudal rectal nerve, which is a branch of the pudendal nerve.[4,5,17] Sphincteric continence is lost if the afferent or efferent fibers of the caudal rectal or pudendal nerve are damaged. The innervation of the rectum also plays a pivotal role in fecal continence and originates from the pelvic plexus, which is closely associated with the peritoneal reflection.[3–5,17]

Multiple studies[4,6,17] have been conducted to evaluate the effects of various colorectal surgeries on fecal continence. Preservation of the external anal sphincter and at least 1.5 cm of the distal portion of the rectum has been recommended to maintain sphincteric continence.[4,5] However, in the present study, resection of the anocutaneous junction was not significantly associated with either transient or permanent fecal incontinence. This may represent a type II error because many of the dogs in which the rectum was resected to the level of the anocutaneous junction underwent only a partial RPT procedure; thus, a substantial portion of the distal aspect of the rectum and anal sphincters were likely preserved in those dogs, which may have falsely increased the incidence of continence. It is also recommended that ≤ 6 cm of the rectum be resected because resection of longer lengths increases the risk for the development of fecal incontinence from either disruption of the pelvic plexus at the level of the peritoneal reflection or loss of rectal mucosa and afferent innervation.[4,6] In the present study, the length of rectum resected was not significantly associated with either transient or permanent fecal incontinence. In fact, many dogs in which > 6 cm of the rectum was resected remained continent following surgery, a finding that was similar to that of another study[5] in which no dogs with rectal resections > 6 cm and concurrent resection of the peritoneal reflection developed permanent fecal incontinence. Because of the retrospective nature of the present study, we were unable to determine whether the peritoneal reflection was resected during the RPT procedures, but it was assumed that resection of long portions (> 6 cm) of the rectum would compromise the peritoneal reflection. On the basis of the findings of the Morello et al study,[5] and because the length of rectum resected was not significantly associated with fecal incontinence in the present study, it seems reasonable to assume that the peritoneal reflection does not represent an anatomic landmark beyond which resection will cause fecal incontinence, which is contrary to findings of other studies.[4,6] The recommendation by Anderson et al[6] that rectal resections should not exceed 6 cm was an absolute measurement and did not account for the size of the dog. To account for dog size in the present study, we calculated the ratio of body weight to length of rectum resected. Other dimensions such as the nose-to-anus length and adjustments for body condition score might have more accurately accounted for the size of the dog in relation to the length of rectum resected, but that information could not be obtained because of the retrospective nature of this study. Furthermore, information regarding the correlation between the length of a dog and its rectal length is lacking.[18] Although calculation of the ratio of body weight to the length of rectum resected might not be an accurate method to standardize the length of rectum resected by body size, neither the length of rectum resected nor the ratio of body weight to length of rectum resected was significantly associated with the incidence of overall fecal incontinence (both transient and permanent incontinence) or permanent fecal incontinence. Therefore, the development of fecal incontinence following RPT surgery is likely multifactorial and may not be associated with the resection of anatomic landmarks such as the peritoneal reflection.

Possible physiologic reasons for the development of fecal incontinence following RPT surgery include disruption of the internal or external anal sphincter or its innervation or stimulation of stretch receptors in the rectum or muscles of the pelvic diaphragm following rectal-to-rectal or rectocutaneous anastomosis.[c] The internal anal sphincter has a primary sensory role in differentiating between solids, liquids, and gases.[17] Loss of internal anal sphincter function may result in a dog being unaware of the contents of the distal rectum and subsequently developing fecal incontinence.

In contrast to the present study, the Swenson procedure, a procedure similar to the RPT procedure, which was first described in 1948 for the treatment of Hirschsprung disease (congenital megacolon) in humans, has been successfully performed for many years without the development of postoperative fecal incontinence.[19] This procedure served as the model for the combined transabdominal transanal approach described by White and Gorman[11] for veterinary patients. The primary difference between the 2 procedures is that the distal 1.5 cm of the rectum is preserved with the Swenson procedure,[19] whereas the procedure described by White and Gorman[11] was developed for the resection of rectal tumors, and the location of such tumors does not always allow for the preservation of the distal portion of the rectum. In the Swenson and Bill study,[19] 15 dogs were used as surgical models for rectal resection in humans. Of those 15 dogs, 12 had normal bowel control with no postoperative fecal incontinence, 2 did not recover from anesthesia, and 1 died because of septic peritonitis secondary to dehiscence of the anastomosis.[19] Fifteen weeks after surgery, 9 of those dogs were euthanized and necropsied, and the anastomotic sites had healed without evidence of stricture in all of them.[19] No other postoperative complications were reported in that study,[19] and the procedure was subsequently performed successfully in numerous children.

The Swenson procedure eventually fell out of favor in human medicine because of a perceived high incidence of postoperative fecal incontinence, urinary incontinence, and sexual impotence.[20] However, investigators of a study[21] published in 1989 reported excellent results with minimal postoperative fecal incontinence following the Swenson procedure in 880 human patients. A modified version of the Swenson procedure similar to the RPT procedure used in the present study has been described[20] for the treatment of human patients with Hirschsprung disease with excellent results. In that study,[20] a transanal approach with or without laparoscopic assistance or with a laparotomy was used to remove aganglionic bowel in 67 children with Hirschsprung disease. The transanal approach involved eversion of the distal rectum with stay sutures placed 1 cm proximal to the dentate line, which preserved the distal 1.5 cm of the rectum. The dentate line is a ring of anal valves that marks the caudal limit of the deepest part of the anus.[22] Monopolar electrocautery was then used to transect the rectum and dissect tissue from the rectal wall so that it could be carefully pulled out and visually examined.[20] The dissection proceeded inside the abdominal cavity beyond the peritoneal reflection.[20] Once the aganglionic tissue was resected, a standard end-to-end anastomosis was performed.[20] This transanal approach preserved the fecal and urinary continence of all 44 children ≥ 3 years of age on whom it was performed.[20]

The reason for the dramatic difference in the incidence of fecal incontinence following a transanal or RPT surgical approach between human and canine patients remains unclear. Levitt et al,[20] the investigators who described the transanal approach, suggest that failure to achieve excellent long-term results in human patients following the performance of that approach is because the dissection of the rectum was too wide, and Levitt[d] suggests that the same may be true for veterinary patients. The key to maintaining fecal continence is to preserve the distal 1.5 cm of the rectum and the dentate line to avoid disruption of the innervation to the terminal portion of the anal canal.[d] Meticulous dissection along the rectal wall should be performed to avoid iatrogenic injury from rough tissue handling or overstretching of the anal canal and damage to the innervation of the distal portion of the rectum and internal and external anal sphincters.[d] As long as the dentate line is preserved and appropriate dissection is used, the overall length of rectum resected is likely unimportant.[d]

In the present study, the only variable that was significantly associated with the development of fecal incontinence following RPT surgery was the extent of circumferential resection; however, this was only found to be significant for fecal incontinence overall and not permanent fecal incontinence. Dogs in which a complete circumferential RPT was performed were 18.6 times as likely to develop either transient or permanent fecal incontinence as were dogs in which a partial (< 360°) RPT procedure was performed. On the basis of these findings, masses located in the terminal 1.5 cm of the rectum or at the anocutaneous junction should be excised by means of a partial RPT surgery to reduce the risk for the development of fecal incontinence provided that complete resection of the underlying disease is not compromised.

The length of rectum resected and the ratio of body weight to length of rectum resected were significantly associated with the development of postsurgical diarrhea. A possible explanation for this finding is that the rectal surface area available for absorption of water from the feces prior to elimination decreases as the length of rectum resected increases. Furthermore, as the length of the remaining rectum decreases, the transit time for feces through the rectum may also decrease and result in a condition similar to short bowel syndrome.[23] Finally, following rectal resection, dogs may develop a hypermotile syndrome similar to that observed in human patients, which causes transient postoperative diarrhea.[d] Fecal incontinence was also significantly associated with diarrhea, which is intuitive since dogs that are unable to control their ability to defecate are more likely to involuntarily leak unformed feces.

The associations observed among the development of postsurgical rectal strictures, constipation, tenesmus, and rectal bleeding in the present study were expected and self-explanatory; however, the protective effect of anocutaneous junction resection on the development

of tenesmus was an unexpected finding. Conceivably, tenesmus would be unlikely in dogs with postoperative fecal incontinence, but in the absence of a significant association between resection of the anocutaneous junction and fecal incontinence, the finding that resection of the anocutaneous junction had a protective effect on the development of postoperative tenesmus is difficult to explain. One possibility is that resection of the rectum proximal to the anocutaneous junction might be inherently more stimulating or irritating than is resection of the rectum in addition to the anocutaneous junction, which could cause postoperative tenesmus. Another possibility is that the increased length of rectum resected associated with RPT surgeries in which the anocutaneous junction is preserved, compared with that associated with surgeries in which the anocutaneous junction is also resected, could result in excessive stretching of the rectum to complete the anastomosis, and the resulting tension might cause irritation or stimulation that leads to tenesmus. Interestingly, the length of rectum resected was not significantly associated with tenesmus. The protective association between anal sacculectomy and tenesmus is most likely a reflection of the fact that anal sacculectomies were performed only in dogs in which the anocutaneous junction was resected; therefore, any variables significantly associated with resection of the anocutaneous junction would likely also be associated with anal sacculectomy.

Although the complication rate following RPT surgery was high for the dogs of this study, the oncological outcome for those dogs was very good. Local recurrence was reported in 13.7% (10/73) of dogs overall with a median time to recurrence of 258 days. Local recurrence is common following incomplete surgical excision of rectal plasmacytomas[24] and apocrine gland anal sac adenocarcinomas[25]; therefore, these results were not unexpected. For the dogs with rectal carcinoma, the local recurrence rate was 19.4% (6/31), which is similar to that (18.2%) reported by investigators of another study.[5] In the present study, local tumor recurrence was not significantly associated with incomplete excision of the mass as determined by histologic evaluation (4 dogs had local recurrence following complete excision, and 5 dogs had local recurrence following incomplete excision). Histologic evaluation was used to determine whether each rectal mass was completely excised regardless of the quality of the margins; therefore, it is possible that masses with narrow margins that were classified as completely excised might have been classified as incompletely excised had additional slides of the mass margins been evaluated. The criteria for a clean surgical margin are controversial and may be dependent on the tumor type. For example, in women with breast cancer, excised tumors with histologically clean 1-mm margins are generally considered adequately and completely excised,[26] whereas in dogs with malignant intestinal tumors, resection of the tumor with gross margins of 2 to 8 cm is recommended.[5,11] Moreover, the reason some dogs in which a mass was incompletely excised did not have local recurrence is unknown. In the present study, only 5 of 18 dogs in which the mass was histologically determined to be incompletely excised developed local recurrence. This rate of local recurrence is similar to those reported by investigators of other studies[27,28] following incomplete excision of other tumor types in dogs such as cutaneous soft tissue sarcoma and MCT.

The overall prevalence of metastatic lesions was 13.9% (10/72) for the dogs of the present study. Metastasis was diagnosed in 4 dogs at the time of surgery, and metastasis or multicentric disease in the sublumbar lymph nodes was suspected for 6 dogs with rectal carcinoma, 1 dog with rectal MCT, and 1 dog with rectal lymphoma. The inability to confirm intra-abdominal metastasis is a limitation of the RPT procedure[4,9] and highlights the need for appropriate preoperative staging, including thoracic radiography, abdominal ultrasonography, and aspiration of any abnormal lymph nodes. Of the 31 study dogs with rectal carcinoma, 3 had metastatic lesions at the time of surgery and 4 developed metastatic lesions after surgery for an overall metastatic rate of 22.6%. The most common site for metastasis was the sublumbar lymph nodes, and this finding was consistent with those of other studies.[5,29,30]

The overall MST for dogs with tumors in the present study was 1,150 days. There was not a significant ($P = 0.33$) difference in survival between dogs with benign and malignant rectal tumors.

Rectal carcinoma was the most common tumor, representing 54.4% of all rectal and pararectal tumors. The MST for dogs with rectal carcinoma was 696 days, which was consistent with previously published MSTs of 24 to 44 months.[3,5,13] Results of another retrospective case series[31] found that dogs with annular colorectal carcinomas had a significantly shorter mean survival time of 1.6 months, compared with 32 months for single polypoid tumors. We were unable to make a similar comparison in the present study because the gross morphological appearance of the rectal tumors was not recorded.

Rectal carcinoma in situ was the second most common tumor observed in this case series and accounted for 12.3% (7/57) of all tumors. In situ carcinomas are malignant tumors confined to the rectal mucosa and are considered a transition between adenomatous polyps and invasive carcinomas. In the present study, the MST was 1,006 days, which is similar to the survival times of 5 to 75 months reported by other investigators.[5,32] Local recurrence rates of up to 55% have been reported[5,32]; however, in the present study, none of the dogs with rectal carcinoma in situ developed either local recurrence or metastasis.

Statistical analysis of other tumor types was not performed because of low case numbers. The few cases of rectal MCT, rectal lymphoma, and apocrine gland anal sac carcinoma all behaved aggressively with a high rate of metastasis, which is consistent with previous reports.[25,27]

The present study had a number of limitations. Because of the retrospective nature of the study, treatment and follow-up protocols were not standardized. The length of rectum that was resected was determined from surgical reports and may have been inaccurate if it was estimated rather than measured. Inaccuracies in the length of rectum that was resected would also affect the calculation of the ratio of body weight to length of rectum resected and its effect on postoperative complications.

The ratio of body weight to length of rectum resected was used to standardize the length of rectum resected with regard to the size of the dog because investigators of another study[6] suggest that resection of > 6 cm of the rectum will cause fecal incontinence; however, those investigators[6] did not consider the size of the dog when they made that suggestion. The ratio of body weight to length of rectum resected might not be an accurate method of standardization because it does not account for the length of the dog or its body condition score. Because of the retrospective nature of the present study, information on dog length and body condition score was unavailable, although it is unlikely that that information would have been useful given that, to our knowledge, there have been no studies performed to determine the association between body length and length of the rectum or the correlation between a subjective body condition score and body weight or dog length. The effect of disruption of the peritoneal reflection, damage to the pelvic plexus, and damage to the external anal sphincter on the development of fecal incontinence could not be assessed because this information was not recorded in surgical reports. Furthermore, it was not possible to determine whether dogs developed sphincteric incontinence, reservoir incontinence, or both because this information was not included in the medical records. This information is important because dogs with reservoir incontinence are likely easier to manage owing to the fact that they are aware of the need to defecate and often defecate more frequently than they did prior to developing reservoir incontinence.

Recommendations for the management of dogs with rectal disease are difficult to make given the results of the present retrospective study. The high complication rate, particularly the rate of development of permanent fecal incontinence (23/74 [31.1%]), associated with RPT surgery might reasonably be considered a justification for not performing the procedure. However, the complication rates for human patients following a procedure similar to the RPT surgery are much lower than those observed in dogs, which suggests that the complications observed in dogs might be primarily dependent on the surgical technique (ie, rough tissue handling or dissection of the rectal wall with excessively wide margins) rather than the actual RPT procedure. Furthermore, in the present study, dogs with the most common rectal tumors (rectal carcinoma and rectal carcinoma in situ) that underwent RPT surgery had a low rate of local tumor recurrence and metastasis and had very good survival times. Finally, surgical procedures other than the RPT procedure might not be practical given the distal location of the rectal disease in many dogs and may be associated with less efficacious local tumor control or have similar complication rates.[1,3–12] For dogs with rectal masses, RPT surgery should be performed only after an informed discussion with the owner, including the risk of complications (both transient and permanent), the impact these complications may have on quality of life, and oncological outcomes.

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**From this month's *AJVR***

## Clinical sensitivity and specificity of a real-time PCR assay for *Campylobacter fetus* subsp *venerealis* in preputial samples from bulls

Alvaro García Guerra et al

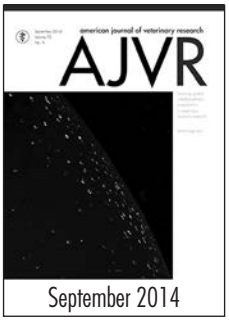
**Objective**—To determine clinical sensitivity and specificity of a quantitative real-time PCR (qRT-PCR) assay for *Campylobacter fetus* subsp *venerealis* (Cfv) in preputial samples of bulls.

**Animals**—313 beef bulls.

**Procedure**—Preputial samples were collected from 300 virgin bulls and 13 Cfv-infected bulls. Specificity of the qRT-PCR assay, determined on the basis of results for samples collected from virgin bulls was compared with specificity of bacteriologic culture performed with transport enrichment medium (TEM). Sensitivity of the qRT-PCR assay, determined on the basis of results for multiple samples collected at weekly intervals from infected bulls was compared with sensitivity of the direct fluorescent antibody test (DFAT), bacteriologic culture, and bacteriologic culture with TEM.

**Results**—Specificity was 85% for the qRT-PCR assay and 100% for bacteriologic culture; results were significantly different. Mean sensitivity was 85.4% for qRT-PCR assay, 82.3% for direct culture in blood agar, 72.1% for the DFAT, 32.7% for direct culture in Skirrow agar, 30% for bacteriologic culture with TEM and blood agar, and 38.1% for bacteriologic culture with TEM and Skirrow agar. Differences in sensitivity among tests varied with ambient outdoor temperature. Repeated sampling significantly increased sensitivity of the qRT-PCR assay.

**Conclusions and Clinical Relevance**—Use of the qRT-PCR assay as a screening test on direct preputial samples had comparable sensitivity to bacteriologic culture, and repeated sampling improved sensitivity. Although improved performance of the qRT-PCR assay, compared with direct bacteriologic culture, was dependent on temperature, transport times that allow direct culture are unlikely under field conditions. The qRT-PCR assay would provide a fast and sensitive screening method for Cfv in bulls. (*Am J Vet Res* 2014;75:852–861)

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