Transanal Pull-Through Rectal Amputation for Treatment of Colorectal Carcinoma in 11 Dogs

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Objective—To evaluate outcome after transanal rectal pull-through amputation of single colorectal adenocarcinoma and in situ carcinoma (Tis) in dogs.

Study Design—Retrospective case series.

Animals—Dogs (n = 11) with colorectal cancer.

Methods—Full-thickness colorectal amputation by either simple transanal (7 dogs) or combined abdominal–transanal (4) pull-through technique.

Results—Adenocarcinoma (8) and Tis (2) were removed with 3–6 cm of grossly normal tissue, cranial and caudal to the tumor, or in 1 Tis with 2 cm grossly normal tissue, cranial and caudal. Two dogs that had a combined abdominal–transanal approach died within 4 days. In the other dogs, postoperative complications included short-term tenesmus (6 dogs), rectal bleeding (11), rectal stricture (3), and long-term fecal incontinence (1). Postoperative recurrence and metastatic rates for adenocarcinoma were 18.2% and 0%, respectively. Median disease-free interval and survival time were not reached. Mean disease-free and overall survival times were 44.3 and 44.6 months (range, 0–75 months), respectively.

Conclusion—En bloc excision of colorectal Tis and adenocarcinoma may be followed by a long survival. Complications of the transanal approach are usually moderate and self-limiting, but complications are more common and severe when more extensive resections are performed through a combined abdominal–transanal approach.

Clinical Relevance—Transanal rectal pull-through amputation is suitable for en bloc resection of colorectal neoplasia. A combined abdominal–transanal approach should be reserved for tumors extending from the mid-cranial region of the rectum to the descending colon.

INTRODUCTION

INTESTINAL TUMORS represent ~ 3% of all neoplasia in dogs, occur more frequently in the large intestine (36–60%), and colorectal tumors appear to be more prevalent in male dogs.1–3 Almost 60% are malignant with adenocarcinoma being the prevalent histotype.3–6 Other less frequent malignant colorectal neoplasms include lymphosarcoma and leiomyosarcoma.7,8 Adenomatous polyps account for most benign rectal tumors.1,2 In situ carcinoma (Tis), a transition between adenomatous polyph and invasive carcinoma, has been reported to have histologic evidence of atypia, which may change to malignancy in 17–50% of dogs.1,2,6,9–12 Rectal adenocarcinoma has been described as nodular (single or multiple), pedunculated, or annular constrictive.3,8,11 Pedunculated or polypoid lesions reportedly have a good prognosis after surgical resection, whereas annular-colorectal adenocarcinoma is characterized by a worse prognosis.1,3 The reported metastatic rate for rectal adenocarcinoma ranges from 0% to 80%.3,11

Several treatments options have been reported for dogs with rectal tumors, including surgical excision by a caudal abdominal approach combined with either pubic...
symphyseal separation or osteotomy, dorsal inverted U approach, rectal pull-through procedure, submucosal polyp resection after mucosal eversion, electrosurgery, cryosurgery, and polypectomy (through an endoscopic approach).\textsuperscript{1,3,6–9,12–20} Recommended margins of resection vary from 1 to 2 cm\textsuperscript{7,12,13} for rectal polyps and malignancies, to a minimum of 2–8 cm\textsuperscript{8,20} for malignancies of both the small and large intestine. For Tis lesions, survival times of 5–24 months have been reported with a recurrence rate of 55%\textsuperscript{9,10} Reported mean survival times for colorectal carcinomas vary from 6 to 22 months after surgical resection, and 24 months after cryosurgery.\textsuperscript{3,6,7} Treatments other than surgery include single high-dose irradiation\textsuperscript{21} and nonsteroidal anti-inflammatory drugs for adenomatous polyps.\textsuperscript{22,23}

We retrospectively evaluate outcome (postoperative and oncologic) after colorectal amputation in dogs with colorectal adenocarcinoma or Tis.

MATERIALS AND METHODS

Inclusion Criteria

Medical records (January 1995–May 2006) were reviewed for dogs with colorectal tumors. Only dogs with a single colorectal adenocarcinoma or Tis treated by transanal pull-through rectal amputation or by a combined abdominal–transanal approach were included.

Data Collected

Data collected included signalment and history; clinical signs and clinical examination findings; diagnostic tests, colonoscopy, and biopsy results; surgical technique, histopathology results, postoperative course, disease-free period, and survival time.

Presurgical Evaluation

Complete hematologic examination, urinalysis, thoracic radiographs (right and left lateral, and dorsoventral projections), abdominal ultrasonography, cardiac examination (auscultation, electrocardiogram, and echocardiography in selected dogs), and tissue sample by colonoscopic biopsy were performed 7–10 days before surgery. For colonoscopy, dogs had food withheld for 36–48 hours but were allowed to drink until 8 hours before examination. Warm water enemas (10–20 mL/kg) were administered twice at 12-hour intervals and an osmotic laxative (polyethylene glycol electrolyte solution, Selg\textsuperscript{TM} 1000; Promefarm S.r.l., Milano, Italy) once orally the day before colonoscopy.

Surgical Procedure

No enema or laxative was administered immediately before surgery and low-residue diet (Hill’s i/d\textsuperscript{TM} Hills Pet Nutrition Inc., Topeka, KS) was started 1 week before surgery. Dogs were prepared for surgery by withdrawing food and water for a minimum of 24 and 8 hours before surgery, respectively. Metronidazole (15 mg/kg every 12 hours orally) was started 72 hours before surgery to decrease colorectal anaerobic bacteria.\textsuperscript{20,24}

Depending on the location and extent of the tumor, transanal rectal pull-through amputation was performed by 1 of the 2 approaches: simple transanal or combined caudal celiotomy and transanal approaches.

Transanal Approach. The perineal area and proximal third of the tail were clipped, and manual evacuation of rectum and anal sacs performed. Dogs were positioned in sternal recumbency, with the tail bandaged and secured dorsally and cranially, and with the pelvic limbs hanging over the end of the surgical table. The rectal wall was everted through the anus with 4 stay sutures.\textsuperscript{24} A full-thickness incision was performed through the rectal wall. When possible, a minimum of 1 cm of distal rectum was preserved. The rectum was mobilized after transection of the rectococcygeal muscle and blunt dissection along the external rectal surface. Stay sutures were used to prevent the cranial segment of the incised rectum from retracting into the abdominal cavity. The mobilized rectum was then retracted caudally and resected. Cranial and caudal margins of 2–6 cm from macroscopic abnormal tissue were attempted, depending on the biopsy results. To establish the point of cranial resection, the rectum was first either externally palpated or longitudinally opened. Finally, the normal cranial region or the rectum or descending colon was anastomosed with the preserved distal rectal stump by simple appositional interrupted suture pattern using 2-0 or 3-0 polydioxanone.

Combined Abdominal Transanal Approach. When the tumor was located in the mid-to-cranial third of the rectum and extended into the descending colon, a combined approach was used by first performing a caudal celiotomy. Regional lymph nodes were resected if enlarged on either ultrasonographic or gross examination. After having grossly measured the feasibility of an end-to-end anastomosis, the colon was isolated by double ligation of the corresponding vasa recta and divided 2–6 cm from the cranial aspect of the tumor. Each colonic stump was oversewn with a continuous Parker-Kerr inverting suture using 3-0 polydioxanone. The 2 stumps were then connected, leaving 1 cm between them, with 4 sutures of 2-0 polyglactin 910 (2 diagonal and 2 straight sutures [Fig 1]), then the celiotomy was closed and the dog repositioned in sternal recumbency. Transanal rectal pull-through amputation was performed as described earlier (Fig 2A and B). After excision of the distal colorectal stump containing the tumor, the oversewn suture was removed from the cranial stump, which was then anastomosed to the remaining rectum as described.

Postoperative Care

Postoperative pain was controlled during the first 24 hours with methadone (0.2 mg/kg intramuscularly [IM] every 4–6 hours), then with buprenorphine (10 µg/kg IM every 6 hours) and/or carprofen (2 mg/kg IM once daily) for at least another 48 hours. Metronidazole (15 mg/kg every 12 hours orally) and amoxicillin–clavulanic acid (20 mg/kg every 12 hours orally)
were administered for 7–14 days. After discharge (4–7 days), administration of carprofen (2 mg/kg/day orally) was continued for 7 days. Dogs wore an Elizabethan collar until complete clinical healing and were fed with a highly digestible diet (Hill’s i/d™). Excised tissue was submitted for histopathologic examination to determine tumor type and evaluate surgical margins.

Histologic Examination and Clinical Staging

Dogs were staged according to the TNM classification proposed by Turrel and Theon (Table 1), and modified by the authors by adding Tis as in situ carcinoma. For rectal adenocarcinoma, this TNM classification considers T1 lesions as invading the mucosa and submucosa only, T2 tumors as extending into but not through the muscularis, and T3 tumors extending into contiguous structures including vessels and lymph nodes.

Outcome

Dogs had clinical examinations every 2 weeks during the first 2 months, then every 3 months for the next 12 months, and then, after 14 months, the owner or referring veterinarian was interviewed by telephone. Follow-up information was updated for a minimum of 6 months. The follow-up examination included a clinical examination (including rectal digital examination) and abdominal ultrasound every 3–6 months during the first 14 months. Referring veterinarians were asked to perform the same tests every 6 months after this period. Fecal continence status was verified clinically.

Statistical Analysis

Numerical and categorical variables were expressed as mean, median, range, and percentage. Dogs were evaluated for postoperative complications, local tumor recurrence, distant metastasis, disease-free interval (defined as the time from surgery to the detection of either local recurrence or metastasis), and survival time (defined as the time from surgery to death including euthanasia). Kaplan–Meier survival analysis was used to determine mean and median disease-free interval and survival time, survival curves, and 95% confidence intervals (CI). Death was considered disease-related if dogs died of surgical complications, local tumor recurrence, or distant metastasis. Dogs dead for unrelated causes, lost to follow-up, or still alive were censored. Analyses were performed using statistical software (R 2.3.0; R Development Core Team: R: A Language and Environment for Statistical Computing. Wien, Austria, R Foundation for Statistical Computing, 2005. ISBN 3-900051-07-0, URL http://www.R-project.org).
RESULTS

Signalment and Clinical Signs

Eleven dogs (9 intact males, 2 intact females) met the inclusion criteria. Breeds were 3 crossbreeds, 2 Maremma sheepdogs, and 1 each of Pointer, Poodle, Italian Hound, West Highland White Terrier, Airedale Terrier, and Labrador Retriever. Age ranged from 6 to 15 years (median, 7 years; mean, 8.3 years) and weight from 9 to 47 kg (median, 25 kg; mean, 25.9 kg). Clinical signs on admission were tenesmus (9 dogs), hematochezia (8), and tumor prolapse from the anus (3). Duration of clinical signs ranged from 3 to 24 months (median, 8 months; mean, 9.3 months). Two dogs had lost weight during the previous 3–6 months and were moderately debilitated.

All but 1 tumor was palpable by digital rectal examination. Lesion distance from the anus ranged from 3 to 6 cm (median, 5 cm; mean, 4.8 cm). Digital rectal examination and colonoscopy were not possible in 1 dog because of partial obstruction by the rectal tumor. Regional lymphadenomegaly was detected by digital rectal examination in 1 dog. Four dogs had local tumor recurrence after excision of adenomatous polyps by the referring veterinarian 4–7 months before admission.

Diagnostic Tests

Laboratory findings were unremarkable except for moderate microcytic hypochromic anemia because of chronic blood loss in 1 dog and normocytic normochromic anemia attributed to chronic disease in another dog.

Lung metastasis was not detected radiographically in any dog. On abdominal ultrasonography, 4 dogs had localized, irregular thickening of the intestinal wall with loss of wall layers and 2 had regional lymphadenomegaly. Rectal lesion length (range, 2–13 cm; median, 4 cm; mean, 3.5 cm) and circumferential extent (range, 90–360°; median, 180°; mean, 172.7°) were determined by clinical examination and colonoscopy. Biopsy specimens were collected during colonoscopy in all but 1 dog where an incisional biopsy was performed after the rectum was everted by applying traction to 4 stay sutures.

Surgical Findings

Transanal rectal pull-through amputation was performed in 7 dogs whereas in 4 dogs a combined approach was used because of extension and/or location of the lesion. Rectal amputation was chosen in 4 dogs, despite endoscopic diagnosis of adenomatous polyp, because of lesion size and/or because the lesion had recurred after earlier excision. The pulled-through rectal segment was opened longitudinally to assess gross margins before resection in 5 dogs operated with the transanal approach only. Moderate tension at the anastomotic site occurred in 1 dog after resection of a 13 cm tumor and cranial and caudal margins totaling 8 cm.

There were 7 adenocarcinomas staged as T1N0M0, 1 adenocarcinoma staged as T3N1M0, and 3 Tis staged as TisN0M0. Final histopathology correlated with preoperative biopsy results in 7 (64%) dogs. Overall cranial gross margins were 2–6 cm (median, 5 cm; mean, 4.4 cm). For adenocarcinoma, the range was 5–6 cm (median, 5 cm; mean, 5.1 cm), and for Tis, the range was 2–3 cm. Overall caudal gross margins were 2–4.5 cm (median, 4 cm; mean, 3.5 cm). For adenocarcinoma, the range was 3–4.5 cm (median, 4.1 cm; mean, 3.8 cm), and for Tis the range was 2–3 cm. In 1 dog, a caudal margin of 3 cm resulted in removal of bowel at the anorectal junction. Histologic tumor infiltration of the cranial margin was detected in 1 dog with adenocarcinoma, but further treatment was refused by the owner. Regional lymphadenectomy was performed in 2 dogs; histology confirmed presence of metastasis in 1 dog and reactive nodes in 1 dog.

Complications

Postoperatively, all dogs had rectal bleeding and tenesmus. Both complications resolved spontaneously within 2 weeks in all but 3 dogs that developed partial rectal stricture causing mild tenesmus. Use of petrolatum orally improved clinical signs and none of these dogs required further surgery because tenesmus resolved within 2 months. Two dogs had fecal incontinence that resolved spontaneously (1 and 5 months after surgery).

Outcome

Four dogs died of tumor-related causes. Two dogs treated by a combined approach died in the immediate postoperative period. One of these dogs died 4 days after surgery because of disseminated intravascular coagulation that failed to respond to medical treatment (sodium heparin, blood transfusion, fluid therapy with colloids, and broad spectrum antibiotics). The other dog died the day after surgery for unexplained convulsions and cardiac arrest. This dog had an excellent recovery from anesthesia and was standing 3 hours after surgery. Necropsy was not allowed in either dog. The other 2 dogs were euthanatized by the referring veterinarians because of local tumor recurrence. Local tumor recurrence was diagnosed by biopsy in 1 dog and necropsy and biopsy in the second dog. Disease-free interval and survival times in these 2 dogs were 4.5 and 20 months, and 6 and 21 months, respectively.

Four dogs died (range, 4–72 months) of unrelated causes. Causes of death in these dogs included dilated
cardiomyopathy (1), gastric carcinoma (1), and unknown reasons (2). The latter 2 dogs did not have evidence of either local recurrence or metastasis. At the time of writing, 3 dogs were alive at 9, 11, and 75 months (21, 23, and 87 months as of March 31, 2008).

Recurrence and Metastatic Rate

Adenocarcinoma. Local recurrence and metastatic rates for adenocarcinoma were 18.2% and 0%, respectively. Mean disease-free interval was 44.3 ± 11.9 months (range, 0–75 months). Mean survival time was not reached; the lower 95% CI was 4.5 months. Mean disease-free interval was 44.6 ± 11.8 months (range, 0–75 months). When data from only dogs that survived the immediate postoperative period (9 dogs) were analyzed, both the median disease-free interval and survival time were not reached; the lower 95% CIs were 20 and 21 months, respectively. Mean disease-free and survival time were 54.2 ± 12.4 and 54.6 ± 12.1 months, respectively.

Tis. Survival time for the 3 dogs with Tis lesions ranged from 11 to 75 months, with 2 dogs still alive at 11 and 75 months, respectively. Local recurrence and/or malignant transformation were not reported in any of these 3 dog with Tis lesions.

Adenocarcinoma. Survival time for dogs with colo-rectal adenocarcinomas ranged from 0 to 72 months. Two dogs died in the immediate postoperative period because of surgical complications. For surviving dogs, survival range was 4–72 months. Of 5 dogs with T1N0M0 stage tumors, 3 (60%) survived a minimum of 21 months, 1 dog was alive at 9 months, and the remaining dog died of unrelated reasons at 4 months. One dog with a stage T3N1M0 adenocarcinoma was euthanatized 6 months postoperatively because of local recurrence.

DISCUSSION

In this case series, signalment and clinical signs were consistent with previously published reports.1,3,6,8,9,12,25 As previously reported,1,8,9 histologic results from endoscopic biopsies should be interpreted with caution because of the risk of sampling very small and superficial tissues that may not be representative of the lesion. In 4 dogs (36.4%), an incorrect histologic diagnosis was obtained from endoscopically collected biopsies. Histologic differentiation of an adenomatous polyp from Tis is important to determine prognosis because the latter has been reported to undergo malignant transformation in 17–50% of dogs.1,2,6,9,12 Malignant transformation in dogs, as in humans, has been reported to occur concurrently with both an increase in tumor size (>1 cm) and number of polypoid lesions.1,10 In these circumstances, they are also more prone to local recurrence.1 The recurrence rate has been reported to be higher for Tis lesions (55%) when compared with adenomatous polyps (17%).4,9 Recurrence also develops later in dogs with adenomatous polyps compared with Tis.9 Four dogs in this series had recurrence after excision of rectal polyps by a referring veterinarian. The histologic diagnosis after our excision was adenocarcinoma in 3 dogs and Tis in 1 dog.

Colonoscopy-combined rectal digital examination was useful to stage the tumor in terms of size, extension, and number of lesions, and to plan surgery.3,9 Other imaging techniques (computed tomography, magnetic resonance imaging) may have provided useful information for treatment planning, especially when neoplastic infiltration of the pelvic extra rectal tissues is suspected.

Surgical Observations

Rectal amputation was performed either by a transanal or a combined caudal abdominal transanal approach.7,24,26,27 An alternative to the combined approach is pubic symphyseal separation or osteotomy. The combined approach was performed in our dogs in preference to either pubic symphyseal separation or osteotomy because of the limited surgical access and complications associated with pubic approaches.6,17,28

Resection was influenced by the need to obtain clean surgical margins and both feasibility (tension at the anastomotic site) and concern for postoperative fecal continence. Except in 1 dog in which a Tis was previously diagnosed as an adenomatous polyp and excised both cranially and caudally with 2 cm margins, simple transanal pull-through allowed exteriorization and amputation of the rectum with cranial and caudal margins of 3–6 and 3–4.5 cm, respectively. To minimize the risk of local recurrence, rectal polyps and Tis lesions should be excised with minimum margins of 2 cm, and rectal adenocarcinomas should be excised with minimum margins of 3 cm.6,12,13,20 Using these guidelines, all but 1 tumor in the present series were completely excised. In this dog, the cranial margin was incomplete despite the tumor being excised with 5 cm of grossly normal tissue cranially. Based on this single dog, 5 cm of grossly normal tissue is recommended for resection of malignant rectal carcinomas, as is recommended for other intestinal malignancies8,29; however, this is not always possible for colorectal tumors because of tension at the anastomotic site15 and the risk of fecal incontinence.

Fecal Incontinence

Fecal incontinence was uncommon in these dogs. The 2 major contributing components to fecal continence are
external anal sphincter function (integrity of both the muscular component and the caudal rectal branch of the pudendal nerve) and reservoir continence.\(^3^0\) Other factors that seemingly contribute to this mechanism are the length of the distal rectum preserved after rectal resection and sparing of the rectal cranial peritoneal reflection.\(^1^5,1^6,2^7,3^1,3^3\) A minimum of 1–1.5 cm of distal rectum has been recommended to be preserved; this was done in all but 1 of our dogs. It is our opinion that this was a key reason for maintaining continence in our dogs.

Fecal incontinence has been associated with amputation of >6 cm of rectum in combination with the peritoneal reflection.\(^1^5\) In our dogs, colorectal amputations of >6 cm always included the peritoneal reflection, but permanent fecal incontinence was not observed. Similar results have been reported after anastomosis of the colon to the distal 1.5 cm of rectum.\(^2^7\) Fecal reservoir continence may be lost after extensive colorectal resection.\(^3^0\)–\(^3^6\) Our dogs did not have typical clinical signs of reservoir fecal incontinence (frequent and conscious defecation).\(^3^7\) Two dogs were transiently incontinent; 1 had the caudal incision at the anorectal junction and was incontinent for 5 months but regained continence after that for unknown reasons whereas the other dog had colorectal resection >6 cm and was transiently incontinent even though the distal rectum was spared at surgery. We may only suppose a transitory disorder, as the continence was regained within 1 month. Therefore, a long follow-up is needed to observe changes in continence.

**Other Complications**

Postoperative rectal bleeding and tenesmus were more frequent than previously reported\(^1^2\) likely because of our more aggressive surgical approach, but these complications were self-limiting. Long colorectal amputation has been reported to be associated with a very high risk of serious complications, such as wound dehiscence and peritonitis,\(^1^,1^5,1^6\) and these may shorten survival time.\(^3\) Risk of dehiscence is reportedly greater with resection >6 cm.\(^8,1^5\) Two of our dogs died in the postoperative period and both had extensive and/or cranially located tumors treated by combined approach. Cause of death was not determined because necropsy was not permitted. Moderate tension of the suture line occurred in 1 dog, but dehiscence was not detected by rectal digital examination.

**Recurrence**

Local recurrence rate was 18.2% and postoperative metastatic rate was 0%. Both dogs that developed local tumor recurrence were operated by a combined approach and 1 had incomplete cranial margins and the second had metastatic regional lymphadenopathy on admission. Preoperative sonographic evaluation and palpation during surgery of the regional lymph nodes represent an important step in the staging dogs with colorectal carcinomas and it is possible that more lymph nodes in this region are enlarged. Any enlarged regional lymph node should be resected or biopsied for histologic evaluation.

Finally, the lack of precise variables to predict outcome of patients with rectal adenocarcinoma other than clinical appearance (nodular, pedunculated, or annular-constrictive) justifies the use of a modified TNM system.\(^2^1\) Based on our results with this modified staging system, long survival times are possible after complete surgical excision of TisN0M0 and T1N0M0 lesions. Rectal transanal pull-through amputation provides an excellent approach for rectal tumors. Colorectal amputation through a combined abdominal and transanal approach was associated with a high complication rate and should be only used for extensive malignant tumors located in the mid-to-cranial third of the rectum and extending into the descending colon. Surgery should be considered palliative for dogs with preoperative metastasis and other adjunctive procedures should be considered (e.g., intraoperative irradiation of metastatic lymph nodes and/or chemotherapy) to improve survival.

**REFERENCES**