A 28.1-kg (61.8-lb) 11-year-old castrated male German Shepherd Dog mix was examined because of a 3-month history of hematochezia and tenesmus. Pertinent history included treatment for Giardia and hookworms 3 months prior, a subcutaneous mast cell tumor removed from the head 2 months prior, and multiple lipoma removals over the previous 6 years. The patient was prescribed a gastrointestinal diet, but no improvement was noted. One month after initial evaluation, abdominal ultrasonography and rectal examination were performed at the referring facility. At that time, a polypoid mass was palpated approximately 6 cm craniad to the anus in the right dorsolateral region of the descending colon just caudal to the pubis. There was no evidence of metastasis on thoracic radiography or abdominal ultrasonography. Results of a CBC and serum biochemical analysis were within reference limits.

Clinical Findings—A 2-cm-diameter sessile polypoid mass was located approximately 6 cm orad to the anus in the right dorsolateral region of the descending colon just caudal to the pubis. There was no evidence of metastasis on thoracic radiography or abdominal ultrasonography. Results of a CBC and serum biochemical analysis were within reference limits.

Treatment and Outcome—Endoscopic mucosal resection (EMR) and snare electrocautery were used to resect the mass and a definitive histopathologic diagnosis of a sessile colorectal polypoid adenoma was made. A 9.9-mm gastroduodenoscope was used during colonoscopy to inspect the mass. To aid in EMR, a 25-gauge endoscopic injection needle was used to infuse sterile saline (0.9% NaCl) solution under the base of the polyp, into the submucosa to elevate the mucosa from the muscularis layer beneath the polyp prior to polypectomy. This was necessary because of the sessile, rather than pedunculated, base of the mass. The entire polyp was successfully removed with endoscopic guidance. The clinical signs of hematochezia and tenesmus resolved immediately, and serial rectal examinations were performed over the following 36 months with no palpable evidence of recurrence.

Clinical Relevance—The patient described in the present report underwent successful colonic EMR and snare polypectomy with no known evidence of mass recurrence during the following 36 months, suggesting that this minimally invasive procedure may be a valuable treatment option for sessile polyps. The advantage of this technique was that elevation of the mucosa via injection of saline solution improved visibility of the polyp and helped to separate the polyp base from the deeper submucosal colorectal tissue, making complete resection possible. (J Am Vet Med Assoc 2014;244:1435–1440)
The colonic mass was not visualized. Fecal examination for parasites and *Giardia* was performed and was also negative. A CBC and serum biochemical profile were performed, and all results were within reference limits.

Serial warm water and lubrication enemas (800 to 1,000 mL/enema) were administered every 4 hours for 18 hours to allow for colonic mucosal cleansing. Following placement of an IV catheter, the dog was started on fluid therapy (3 mL/kg/h [1.36 mL/lb/h]) for 24 hours prior to anesthesia.

The dog was premedicated with IM administration of hydromorphone (0.1 mg/kg [0.045 mg/lb], IM) and midazolam (0.25 mg/kg [0.11 mg/lb], IM), and general anesthesia was induced with propofol (3 mg/kg [1.36 mg/lb], IV). The patient was intubated, and anesthesia was maintained with isoflurane in oxygen. The dog was then positioned in left lateral recumbency. Cefoxitin (30 mg/kg [13.6 mg/lb], IV) was administered at the beginning of the procedure and was repeated every 2 hours (20 mg/kg [9 mg/lb], IV).

A colonoscopy was performed with a 9.9-mm gastroduodenoscope. A polypoid mass was found (Figure 1) located in the right dorsolateral region of the distal colon, as previously palpated. The mass was approximately 2 cm in diameter. Prior to polypectomy, biopsy samples were obtained endoscopically from the proximal ascending, transverse, and descending colon with a 2.8-mm endoscopic cup biopsy instrument during a colonoscopy examination from the ileocolic junction to the level of the rectum. No other masses were seen throughout the colon, and the visual endoscopic appearance of the colon was considered normal. Next, a 6-mm gastroduodenoscope was inserted to the level of the polypoid mass. By use of a 2.0-mm endoscopic polypectomy device with a 2-cm loop, the mass was manipulated to better assess the base. Because of the broad-based, sessile nature, the snare was removed, and a 25-gauge endoscopic injection needle was inserted through the working channel of the endoscope to aid in EMR. The needle device was primed with bacteriostatic sterile saline (0.9% NaCl) solution to remove all the air in the syringe and device. The needle was inserted under the base of the polyp into the submucosal tissue, and approximately 0.25 mL of saline solution was injected into the submucosa, creating a large enough pocket of fluid to separate the mucosa from the deeper tissue layers of the colon. This allowed the mass to become more pedunculated so that it could be resected more carefully at the base, avoiding the muscularis layer (Figures 1 and 2). The needle was then removed, and the snare device was placed around the base of the polyp to the base of the mass, including the saline solution bleb in the submucosa. This assisted in achieving an appropriate depth of resection with EMR, while protecting the deeper tissues from thermal burn and perforation. The snare device was attached to the electrocautery unit. With the electrocautery foot pedal, a power of 15 W was used to remove the mass at the base in the monopolar blend mode (ie, a combination of both coagulation and cutting). Caudal traction was placed on the mass with the polypectomy snare device to prevent it from touching the wall of the colon orad to the mass, which was not easily seen during the polypectomy. Snare electrocautery removed the polyp from its base, including the entire mucosa and a portion of submucosa, and the

Figure 1—Endoscopic images of a colonic polyp obtained during colonoscopy in an 11-year-old castrated male mixed-breed dog with hematochezia and tenesmus. Abdominal ultrasonography and rectal examination prior to referral revealed a colorectal polyp, diagnosed as a benign colorectal polypoid adenoma after histologic examination of tissue samples. A—A polypoid mass in the distal descending colon with a broad base. The mass is approximately 2 cm in diameter. An endoscopic injection needle is passed inside a safety sheath through the working channel of the endoscope prior to EMR. B—The endoscopic needle inserted under the colonic mucosa during infusion of saline (0.9% NaCl) solution created a pocket of fluid separating the mucosa from the other layers of the colon. C—After saline solution infusion, the polyp is shown to be more pedunculated. D—The snare device is placed around the base of the polyp. Via electrocautery, the mass is removed at the base. E—A nonbleeding, intact area of the colonic wall (black arrow) from which the polyp was removed is seen, and the polypoid mass is free within the lumen (black asterisk) prior to retrieval.
A polyp was retrieved from the colonic lumen with the same snare device. Once the mass was removed, it was submitted for histologic evaluation. Colonoscopy was then repeated, confirming that there was no evidence of colonic wall perforation. With use of a 50% mixture of contrast medium and saline solution, a colonogram was then performed by means of fluoroscopic guidance, further confirming no extravasation or perforation. The mixture was then suctioned from the colon, and the dog recovered uneventfully from anesthesia. The total procedure time for colonic polyp resection was 30 minutes.

Because of the presumptive diagnosis of chronic inflammation contributing to the formation of a colonic polyp, the dog was prescribed metronidazole (13 mg/kg [6 mg/lb], PO, q 12 h) and additional dietary fiber. The dog was discharged 4 hours after the procedure.

Histologic evaluation of the mass revealed a colonic polypoid adenoma (no features of dysplasia to suggest carcinoma) isolated to the mucosal layer and no evidence of invasion of the underlying submucosa, confirming that a full resection was accomplished. The proximal and distal colonic mucosal biopsy specimens were normal colonic mucosa.

The hematochezia and tenesmus resolved immediately after the polypectomy. Repeated colonoscopy was recommended at 6- to 12-month intervals to assess for additional or recurrent polyp formation or transformation of the site to invasive colorectal adenocarcinoma, but this was declined. For the following 36 months, serial rectal exams were performed at 3, 6, 13, 24, 30, and 36 months by the referring veterinarian, and the dog had no clinical signs or evidence of polyp recurrence. The dog was ultimately euthanized 37 months later for metastatic hemangiosarcoma.

Discussion

Colorectal polyps are generally considered to be the most common benign colorectal tumor in dogs. An increased prevalence is suggested in Poodles, Airedale Terriers, German Shepherd Dogs, and Collies. Common clinical signs include hematochezia, constipation, tenesmus, mucous in feces, dyschezia, and ribbon-like feces. Dogs with benign polypoid masses do not typically have signs of systemic illness. If there are associated systemic signs, such as weight loss or inappetance, then malignant disease is considered more likely. Masses found in the region of the colorectal junction in dogs may be single, multiple, benign, or malignant. The most common benign mass is a polyp, defined as a grossly visible protrusion from the mucosal surface of either neoplastic or nonneoplastic cells. The most common colorectal masses are adenomatous polyps, inflammatory polyps, carcinoma in situ, and adenocarcinomas. Other reported colorectal tumors include lymphosarcoma, leiomyoma, leiomyosarcoma, plasmacytoma, and inflammatory pseudopolyps.

In dogs, most polyps occur in the distal colon at the colorectal junction, but they may also be found more proximally within the colon. When polyps are found in this region, they are characterized on the basis of gross appearance and adherence to the colon wall. Most appear dark red or pink and are often soft, friable, and hemorrhagic. In human patients, colonic polyps may be single or multiple.

In dogs, benign polyps are histologically classified as either hyperplastic or adenomatous and diagnosed as benign if the epithelial changes do not cross the mucosal basement membrane to the lamina propria. However, if atypical cell morphology is noted in the mucosal layer on histologic analysis, the polyp may be considered carcinoma in situ. Once tumor cells cross the basement membrane into the lamina propria, the polypoid mass is considered an invasive carcinoma. Polypoid adenomatous masses and carcinoma in situ have the potential to progress or transform to invasive carcinoma and should be followed carefully and ideally removed. It is unclear what percentage of benign colorectal polyps (hyperplasia and adenoma) will transform to invasive neoplasia. One study of dogs found an 18% transformation rate (8 to 37 months after diagnosis) of all colorectal polyps, but when the polyp was solitary, it was only 7%, and transformation was considered more common with carcinoma in situ than solitary adenomas or hyperplastic tissue. Colorectal polyps (adenoma or hyperplasia) have an unknown cause; it is thought that they are typically a result of colonic irritation, which may occur from inflammatory bowel disease, infectious etiology, parasites, or chronic diarrhea from various causes.
In human patients, colonoscopy has become the mainstay of the diagnosis and treatment of large bowel disease. This offers a more sensitive means of screening and diagnosing colorectal tumors as well as subsequent surveillance. In humans, presurgical biopsies, including submucosa, are recommended to obtain a more definitive diagnosis, which aids in determining prognosis and evaluating treatment options. The endoscopic appearance of a polyp does not appear to be an accurate indicator of its histologic nature (ie, sessile, flat, or pedunculated), although interestingly, the presence of a saline solution lift has been reported to be suggestive of the level of invasiveness of the mass. Typically, if the mass does not lift off the submucosa during saline solution injection, it is considered invasive below the basement membrane, and more aggressive surgical interventions are indicated for full resection.

Depending on the definitive histopathologic diagnosis of the colorectal lesion, treatments range from medical management, including diet change and anti-inflammatory treatment, to various endoscopic and surgical procedures. Because of the higher morbidity rate associated with more invasive transabdominal colorectal surgeries, the trend among human gastroenterologists is toward use of therapeutic endoscopy to perform colorectal mass resection whenever possible. Minimally invasive options include transanal endoscopic microsurgery, endoscopic submucosal dissection, EMR, laparoscopy for polypectomy or resection and anastomosis, and radiation therapy. Radiation therapy is indicated only for masses of <3 cm in diameter confined to the rectal wall in the distal rectum and anal canal when polypectomy is not an option. However, the effect of radiation on surrounding neurovascular structures and the risk for colorectal stricture formation are the main contraindications to this modality.

Polypectomy of colonic polyps is the mainstay of treatment in human gastroenterology and has been reported to reduce the risk of cancer progression in humans by interrupting the progression from adenoma to carcinoma. This progression is most commonly seen with carcinoma in situ. Because of this risk, the associated symptoms, and the need for accurate histologic evaluation, removal is indicated. The term polypectomy is used when referring to removal of lesions measuring <2 cm in diameter with an electrocautery snare alone; the term EMR is used when the polypectomy is done after fluid (saline solution, sterile water, saline with methylene blue, or epinephrine) is infused in the submucosal tissue under the base of the mass separating the mucosa from the muscular layers. This is typically done for larger, more sessile lesions. It allows a safer resection, protecting the deeper tissue from both thermal injury and perforation during electrocautery.

In contrast with the minimally invasive method of diagnosis and treatment of colorectal polyps practiced in human medicine, the current standard of care in veterinary medicine is surgical resection including colonic resection and anastomosis, subtotal colectomy, cryosurgery, rectal pull-through surgery, submucosal resection via rectal pull-out technique, or minimal colectomy with polyp resection. If the lesion is at the colorectal junction, it is usually not amenable to colonic mucosal pull-through, requiring the mass to be excised transabdominally or via pelvic osteotomy. A few facilities around the world are more commonly performing polypectomy procedures, but this is not yet considered the standard of care in the veterinary field. In human medicine, endoscopic polypectomy is also commonly performed for gastric, nasal, tracheal, and urinary bladder polyps. These are not commonly reported in veterinary medicine but have been performed in our practice with a minimally invasive technique similar to that described for human patients.

A polypectomy is typically performed with the aid of an endoscopic snare that is manually closed to entrap the base of the tissue. With monopolar electrocautery that produces simultaneous cutting and coagulation, the polyp can be resected at the base from the colorectal wall. Prior to electrocautery, the polyp is retracted away from its base into the lumen of the colon or rectum, tenting the wall to prevent iatrogenic trauma to the adjacent deep colonic layers. To address the variety of polyp profiles, there are a wide variety of snare types, with oval and hexagonal snares being the most commonly used. However, in cases of flat or sessile polyps, where getting the snare around the base of the mass is more difficult, EMR techniques are becoming widely used in human patients.

In combination with snare polypectomy, EMR (Figure 2) involves the placement of a submucosal injection beneath the base of a flat or more sessile mucosal mass, elevating it from the deeper tissue layers, separating the mucosa from the muscular layer. This provides 3 potential benefits. The injection identifies lesions invading the submucosa or muscle layer by giving a nonlifting sign, making this type of lesion less suitable for endoscopic removal; it raises a flat lesion into a more pedunculated dome, which can be more readily removed with a snare; and separates the mucosal mass away from the muscle layer, reducing the risk of perforation or transmural thermal injury. Endoscopic mucosal resection was used in the patient described in this report, making a sessile mass more pedunculated for an easier, safer, and deeper resection.

The procedure described, originally known as a strip-off biopsy, was first reported in 1984 in Japan. Because the injected fluid may diffuse quickly, multiple injections may be necessary to allow for polyp elevation, making the lesion more amenable to complete endoscopic resection. A bleb formed by saline solution typically lasts 3 to 10 minutes in our experience, so once the injection is satisfactory, the polypectomy should be performed. The use of sterile water may last longer than saline solution in some endoscopists’ experience. The fluid also exerts a tamponade effect on the blood vessels, potentially providing additional hemostasis.

Snare polypectomy is performed with a blended, coagulation, or pure cutting electrical current. The purpose of combining electrocautery with the snare polypectomy is to provide additional power when incising the tissue, which provides hemostasis within the colon. More heat causes cellular bursting and tissue cutting, whereas less heat causes cell shrinkage and tissue coagulation. One study found that histologic evaluation of the polyp may be influenced by the type of
electrical current used for polypectomy, which means consideration must be taken when practitioners decide the type of electrocautery to use for a polyp removal procedure. The use of a lower electrical current setting (resulting in coagulation) may be associated with more delayed postpolypectomy hemorrhage, whereas the use of a higher electrical current, resulting in cutting and a blended current, is thought to be associated with more immediate hemorrhage and potential perforation.32 Because of this, the power can be steadily increased to an effective level. In humans, the recommended power ranges from 15 to 70 W.15 In dogs, 15 to 20 W has been considered a good palliative option.36

In our clinical experience and in the successful outcomes in human patients, if complete excision of a benign mass is accomplished, the prognosis for full recovery and elimination of clinical signs is generally good to excellent, as in the dog of this report. If the benign mass is incompletely excised, recurrence and malignant transformation are possible and should be monitored for. Colonic masses causing an annular, napkin-ring, or apple-core appearance have been found to be associated with the shortest survival time in dogs, and these are more commonly associated with invasive carcinomas rather than inflammatory or adenomatous polyps.3 For these cases, other more aggressive surgery is not elected, a colonic stent may be considered a good palliative option.36

In conclusion, the dog of this report had a successful colonic EMR and polypectomy for a sessile colorectal polypoid adenoma. No recurrences of the mass or clinical signs were seen in the following 3 years. This procedure, which used a saline solution injection to better define the polyp margins, protect the deep layers from thermal injury, and obtain a better depth of resection, was safe, minimally invasive, and effective. This can be considered prior to more aggressive surgeries when the mass is not easily accessible through the anus or when a more minimally invasive endoscopic removal is desired. To make further recommendations and better describe the risks and benefits of this procedure, a study including a larger number of dogs should be performed.

References


b. 9.9-mm gastroduodenoscope Q160, Olympus, Melville, NY.
c. 2.8-mm endoscopic cup biopsy instrument, Olympus, Melville, NY.
d. 6-mm gastroduodenoscope XP160, Olympus, Melville, NY.
e. 2.0-mm endoscopic snare electrocautery device, Olympus, Melville, NY.
f. 25-gauge endoscopic injection needle, Olympus, Melville, NY.
g. Electrocautery Force EZ unit, Covidien, Mansfield, Mass.
h. Omnipaque, Iohexol 240 mg/mL, GE Healthcare, Princeton, NJ.
From this month’s AJVR

Comparison of cardiac output determined by an ultrasound velocity dilution cardiac output method and by the lithium dilution cardiac output method in juvenile horses with experimentally induced hypovolemia

Andre C. Shih et al

**Objective**—To assess the accuracy of an ultrasound velocity dilution cardiac output (UDCO) method, compared with that of the lithium dilution cardiac output (LiDCO) method, for determination of cardiac output (CO) in juvenile horses with experimentally induced hypovolemia.

**Animals**—12 anesthetized 2- to 6-month-old horses.

**Procedures**—For each anesthetized horse, CO was determined by the LiDCO and UDCO methods prior to any intervention (baseline state), after withdrawal of approximately 40% of the horse’s blood volume (low CO state), after maintenance of hypovolemia and infusion of norepinephrine until mean arterial blood pressure was equal to baseline value (high CO state), and after further infusion of norepinephrine and back-transfusion of withdrawn blood (posttransfusion state). For each of the 4 hemodynamic situations, CO and calculated cardiac index (CI) values were obtained by each method in duplicate (8 pairs of measurements/horse); mean values for each horse and overall mean values across all horses were calculated. Agreement between CI determined by each method (96 paired values) was assessed by Bland-Altman analysis.

**Results**—For the UDCO method–derived CI measurements among the 12 horses, mean ± SD bias was −4 ± 11.3 ml/kg/min (95% limits of agreement, −26.1 to 18.2 ml/kg/min) and mean relative bias was −10.4 ± 21.5% (95% limits of agreement, −52.6% to 31.8%).

**Conclusions and Clinical Relevance**—Results indicated that, compared with the LiDCO method, the UDCO method has acceptable clinical usefulness for determination of CO in foals. (Am J Vet Res 2014;75:565–571)