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Complications associated with modified closed anal sacculectomies using monopolar electrosurgery in 113 dogs

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Objective
The objective of this study was to report on the complication rate for monopolar electrosurgery in modified closed anal sacculectomy in dogs.

Methods
Medical records from January 2015 to June 2024 were retrospectively reviewed for the use of monopolar electrosurgery in modified closed anal sacculectomy in dogs. Inclusion criteria consisted of a presurgical physical examination; all surgery, anesthesia, diagnostic imaging, and histopathology reports; postoperative recheck examination for incision status; and any postoperative complications. Two time points were evaluated: day 1 and the postoperative period (day 2 until the final incisional evaluation).

Results
125 incisions were included. No intraoperative complications were reported. Fifteen percent of incisions on day 1 experienced postoperative complications (swelling and bruising), while 9% of incisions within the postoperative period experienced complications (incisional dehiscence and incisional discharge). No significant association was found between postoperative complications and the weight of the patient, presence of diarrhea, presence of neoplasia, size of anal sac lesion, or incomplete excision. Incomplete excision had a significant association with local recurrence.

Conclusions
Most postoperative complications, such as swelling, bruising, and incisional discharge, were self-limiting. Incomplete excision significantly increased the odds of recurrence. Postoperative complication rates were similar to those in previous studies not utilizing total electrosurgical dissection.

Clinical Relevance
Monopolar electrosurgery can be used for surgical approach and dissection in modified closed anal sacculectomy.

Keywords: anal sacculectomy, modified closed, complications, electrosurgery, neoplasia

Most neoplasms arising from the apocrine glands are malignant, with apocrine gland anal sac adenocarcinoma (AGASACA) being the most common.[1,2] Other types of reported perianal neoplasia include sebaceous adenoma and adenocarcinoma, squamous cell carcinoma, malignant melanoma, mast cell tumor, epitheliotropic lymphoma, and hemangiosarcoma.[1,2] Although AGASACA is commonly treated surgically, other treatment modalities such as radiation therapy and chemotherapy are alternative primary or adjuvant treatment options.[3,4] Common nonneoplastic pathologies of the anal sacs include anal sacculitis, anal sac impaction, and anal sac abscesses.[5–7] Local treatments such as manual expression, flushing of the anal sacs, and instillation of antibiotics into the anal sac are the first line of treatment for these disease processes, but if recurrence continues, surgical excision of the anal sacs is recommended.[6,7]

Anal sacculectomy is a common surgical procedure used for a variety of anal sac diseases ranging from infectious to neoplastic causes. Various surgical approaches have been described for anal sacculectomy with the goal of removing the anal sac and its accompanying lesion. The traditional open approach allows for complete removal of the anal sac and its associated duct but has increased risk of contamination due to the incision into the anal sac exposing the internal lining and contents.[8,9] In contrast, the traditional closed approach does not incise into the anal sac. Although this approach creates less contamination, the entire duct may not be excised.[10,11] Complication rates for traditional closed anal sacculectomy range from 5% to 32%, while rates of up to 54% are reported for the traditional open approach.[8,12–14]

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The modified closed approach allows for complete removal of the anal sac, including the duct opening, without opening the anal sac.[15] This may minimize the incidence of local recurrence,[16] although it has yet to be proven.[17] The modified closed approach has been shown to have low to moderate postoperative complication rates reported from 6% to 42%,[15-18] which is comparable to the traditional closed approach.[13] Short-term postoperative complications are similar between all 3 approaches and are generally self-limiting or medically managed.[8,12-18] These include discharge, bruising, inflammation, excessive scooting, and incisional infection.[8,12-18] Long-term complications include fecal incontinence, rectal fistulation, anal stricture, and local recurrence, although the prevalence of these complications is low.[8,12-18]

Cold steel encompasses sharp instruments that do not utilize heat or any other energy-based modalities, such as scalpel blades. Cold steel is often used for the anal sacculectomy surgical approach, with electrosurgery used to aid in hemostasis and dissection throughout the procedure. Electrosurgery converts electrical currents into thermal energy, which is utilized to both coagulate vessels and dissect away soft tissues throughout the surgical procedure.[19] However, this process could also increase the risk of thermal trauma to the surrounding soft tissues and inhibit healing.[20] Electrosurgery has been shown to reduce pain, inflammation, and improve hemostasis within incisions in recent human studies.[21-23] Human postoperative complication rates for incisions made with cold steel were reported at 6% to 12% versus 4% to 15% for electrosurgery, with no significant difference.[21-23] Similar results have also been shown in veterinary medicine when electrosurgery is used for abdominal laparotomy approaches.[24] No postoperative complications were reported for incisions made with electrosurgery, and all incisions healed for both the cold steel and electrosurgical groups.[24] Previous veterinary studies have utilized electrosurgery for either the incisional approach[18] or dissection[15-17] for anal sacculectomy, but there are limited studies evaluating the use of electrosurgery for both incisional approach and dissection.[25,26] To our knowledge, there are no studies evaluating postoperative complication rates with the use of electrosurgery for both the approach and dissection in modified closed anal sacculectomy. The objective of this study was to report on the complication rate for monopolar electrosurgery in modified closed anal sacculectomy in dogs.

Methods
Study design
This study utilized a retrospective cohort design to investigate postoperative incisional complications occurring in dogs undergoing unilateral or bilateral anal sacculectomy utilizing electrosurgery at the VCA West Coast Animal Specialty and Emergency Animal Hospital (VCA WC). Medical records from VCA WC between January 1, 2015, and July 20, 2024, were reviewed for unilateral or bilateral anal sacculectomy. The unit of this study was each individual incision and postoperative observations related to the individual incision, not the dog.

Eligibility criteria
Only dogs were included in this study. Inclusion criteria consisted of a complete presurgical physical examination, complete medical records (including all surgery, anesthesia, diagnostic imaging, and histopathology reports), postoperative recheck examination for incision status, and any postoperative complications. Dogs were excluded if surgery was performed by a locum surgeon at the study clinic or medical records were incomplete or unavailable for review.

Data collection
Demographic data of age, sex, breed, and weight were recorded. Medical records were reviewed, and the diagnosis prior to surgery, histopathologic diagnosis and surgical margins, use of perioperative and postoperative antibiotics, occurrence of perioperative or postoperative complications, and any local recurrence were documented. Surgical margins were not evaluated beyond complete versus incomplete as reported on the histopathology report. The size of neoplastic lesions were reported on the basis of CT scan or ultrasonography. If lesion size was unavailable on diagnostic imaging, it was recorded on the basis of a rectal examination, as anal sac lesion size has been shown to be comparable between the 2 modalities.[27] A *postoperative complication* was defined as any deviation from the normal postoperative course.[28] If postoperative complications occurred, a description of the complication was documented as well as the treatment plan. Postoperative complications were graded on the basis of the Accordion Severity Grading System of Surgical Complications (ASGS) by Strasberg et al,[28] from grade 1, mild complications that required a minor procedure, to grade 4, resulting in postoperative death. Postoperative complications were also graded by the Veterinary Cooperative Oncology Group Common Terminology Criteria for Adverse Events (VCOG) by LeBlanc et al,[29] from grade 1, asymptomatic or mild symptoms with no intervention indicated, to grade 4, either euthanasia or natural death.

Surgical procedure
Anal sacculectomy was performed by use of the modified closed approach as previously described by Chen et al.[15] All incisions and dissection were performed with monopolar electrosurgery (Force TriVerse; Medtronic). Both coagulation and cut settings were set at 15 W. A traditional 3.5-mm cautery tip was used throughout the entire procedure. A sterile gauze was lubricated and placed within the rectum during surgical preparation, prior to sterile preparation in the operating room. The entire procedure is depicted pictorially in **Figure 1**. A closed mosquito hemostat was placed within the anal sac opening to identify the anal sac, and an incision was made through the skin, along the length of the anal sac. The hemostat was then removed from the anal sac and replaced with a new hemostat to clamp along the previously made incision along the anal duct opening. A circular incision was made around the opening of the anal duct. The surrounding subcutaneous tissues were carefully

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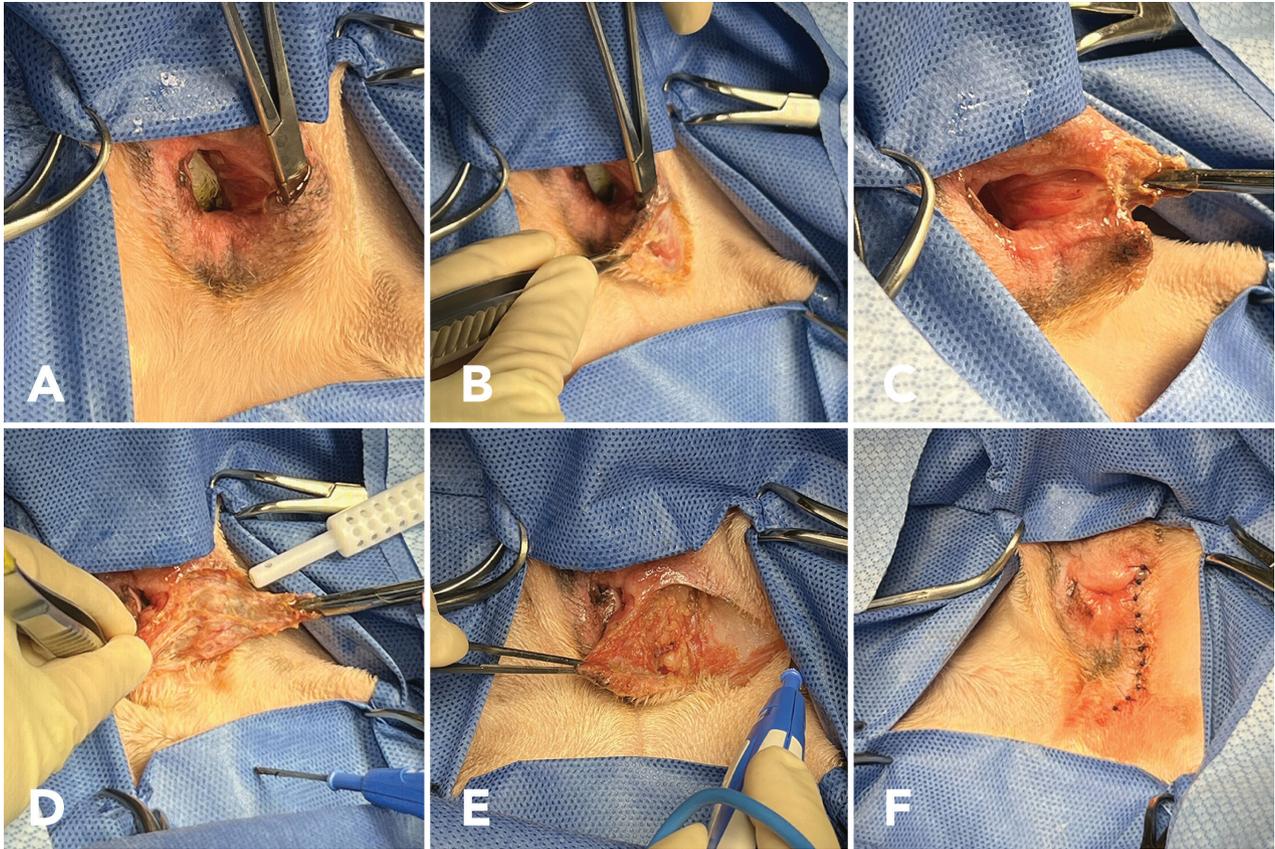
Figure 1—Surgical procedure for modified closed approach to anal sacculectomy with the use of monopolar electrocautery dissection in a dog. A—Closed mosquito hemostats are placed within the anal duct to identify the anal sac. B—A linear incision is made through the skin along the anal sac. C—A circular incision is made around the opening of the anal duct. D—The external anal sphincter and subcutaneous tissues are dissected away. E—The anal sac, mass, and duct are marginally excised. F—The external anal sphincter and subcutaneous tissue layer are closed with 3-0 poliglecaprone 25 (Monocryl) or 3-0 polydioxanone (PDS) in a simple continuous pattern. The subcuticular layer is closed with 3-0 poliglecaprone 25 (Monocryl) in a continuous intradermal pattern. The skin is closed with 3-0 poliglecaprone 25 (Monocryl) in a simple interrupted pattern.

dissected away. Dissection was performed along the anal sac to avoid perforation into the rectum. The anal duct, anal sac, and associated lesion were marginally excised. The site was lavaged with sterile saline, and gloves and instruments were changed. The external anal sphincter was apposed, if feasible, and the subcutaneous layer was closed with either 3-0 poliglecaprone 25 (Monocryl) or 3-0 polydioxanone (PDS) in a simple continuous pattern. The subcuticular layer was closed with 3-0 poliglecaprone 25 (Monocryl) in a continuous intradermal pattern. The skin was closed with 3-0 poliglecaprone 25 (Monocryl) in a simple interrupted pattern. The majority of incisions were closed with 3-0 poliglecaprone 25 (Monocryl) for all layers. The gauze was removed from the rectum, and a rectal examination was performed to evaluate for any rectal perforations. All surgeries were performed by a board-certified surgeon or board-certified surgeon with American College of Veterinary Surgeons fellowship status in surgical oncology. All dogs received perioperative antibiotics of cefazolin at 22 mg/kg or ampicillin-sulbactam (Unasyn) at 30 mg/kg IV every 90 minutes during the surgical procedure.

Follow-up period

A 2-week course of oral antibiotics was prescribed postoperatively for all dogs, consisting of either amoxicillin–clavulanic acid (Clavamox) at 13.75 mg/kg twice daily, marbofloxacin at 5 mg/kg once daily, or cefpodoxime at 10 mg/kg once daily. Oral analgesic medications consisted of gabapentin at 3 to 10 mg/kg twice to 3 times daily for 5 to 7 days and an NSAID (either carprofen, 2.2 mg/kg twice daily, or meloxicam, 0.1 mg/kg once daily), if clinically applicable, for 3 to 5 days. Clients were instructed to wear gloves and apply zinc oxide cream (Desitin) to the incision 3 to 4 times daily. If fecal contamination occurred, clients were instructed to gently blot the incision with a clean paper towel. An Elizabethan collar was instructed to be worn at all times during the postoperative recovery period. If postoperative diarrhea was present, it was treated with a short course of metronidazole at 10 mg/kg, PO, twice daily for 5 to 7 days. For the purposes of this study, 2 types of follow-up times were investigated: (1) day 1 and (2) the postoperative period. Day 1 follow-up occurred the day following the surgical procedure. The postoperative period encompassed the days occurring

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after day 1 and until the last day of postoperative follow-up. All clients received a follow-up phone call within 3 to 7 days postoperatively and were scheduled for an incisional evaluation as close to 14 to 21 days postoperatively as possible. The dog was scheduled for reevaluation sooner if any concerns were mentioned at the follow-up phone call.

Statistical analysis

Age, sex, breed, and weight of dogs were analyzed descriptively and reported. Mean, median, IQR (interquartile range), and range of age and weight were reported. The frequencies and proportions of spayed and intact females and castrated and intact males were reported. The number of neoplastic and nonneoplastic conditions was reported. Neoplastic conditions were further subdivided into AGASACA versus non-AGASACA. The median maximal diameter of neoplastic lesions, number of incisions with local recurrence, and histopathologic diagnosis and surgical margins were reported. Associations between excision status and local recurrence were examined with logistic regression. The number and type of postoperative complications, time of occurrence, and any indicated treatments were recorded. The most common complications were reported on the basis of frequency. The complication grades at the postoperative examination were provided. The effects of maximal diameters of anal sac lesions on incisional complications were investigated. Lesions were considered large if their maximal diameter was > 5 cm. Lesions were considered small if their maximal diameter was ≤ 5 cm. The Fisher exact test was used to determine associations between postoperative complications and incisions between dogs above and below 15 kg, the presence of pre- and postoperative diarrhea, the presence of neoplasia, and excision status of neoplastic lesions. R statistical software, version 4.4.1 (The R Project for Statistical Computing), was used to perform all statistical analyses and 95% CIs.[30]

Results

Demographics

A total of 125 incisions (113 dogs) were enrolled. Twelve dogs had bilateral surgeries. The mean and median ages of enrolled dogs were 10.5 and 10.4 years (IQR, 9.4 to 12.4 years; range, 3.5 to 16.1 years). The distribution of sex and intact status for enrolled dogs is shown in **Table 1**. The most frequently enrolled dog breed was mixed breed. Mixed-breed dogs (n = 29), Labrador Retrievers (15), and Golden Retrievers (10) were the only breeds with

10 or more dogs enrolled. The mean and median weights of enrolled dogs were both 22.6 kg (IQR, 9.77 to 32.8 kg; range, 4.44 to 50 kg).

Surgical and antibiotic protocols

Seventy-five percent of incisions were closed with poliglecaprone 25 (Monocryl) for all layers, and 25% were closed with polydioxanone (PDS) for the deep subcutaneous layer and poliglecaprone 25 (Monocryl) for the subcuticular and skin layers. One hundred percent of incisions received perioperative antibiotics, with 1% receiving ampicillin-sulbactam and 99% receiving cefazolin. At discharge, 64 incisions (51%) were prescribed with marbofloxacin, 49 incisions (39%) were discharged with amoxicillin–clavulanic acid, and 12 incisions (10%) with cefpodoxime.

Histopathologic diagnoses

The most common histopathologic diagnosis was neoplasia (n = 109), specifically AGASACA (100). Other neoplastic diagnoses were hemangiosarcoma of the dermis involving the anal sac (n = 1), high-grade perianal carcinoma (1), mast cell tumor (2), melanoma (1), and perianal adenoma overlying the anal sac (4). The median maximal diameter of AGASACAs was 1.5 cm (IQR, 0.9 to 2.95 cm; range, 0.2 to 7.3 cm). The median maximal diameter of all anal sac neoplastic lesions was 1.5 cm (IQR, 0.8 to 2.75 cm; range, 0.2 to 7.3 cm). Nonneoplastic lesions (n = 16) included impaction (11), anal sacculitis (4), and a granulomatous cyst (1).

Local recurrence

Among 100 incisions treating AGASACA, 15 were incomplete excisions. Of these, 4 (27%) experienced recurrence. Of the 85 incisions with complete excisions, 5 (6%) experienced recurrence. A significant association between local recurrence and excision status was detected (OR, 5.82; P = .02). The median time to detection of local recurrence was 343 days (IQR, 343 to 397 days; range, 25 to 960 days).

Day 1 incisional complications

No dogs experienced intraoperative surgical complications. Postoperative complications occurred in 19 incisions (15%) at day 1, with swelling (n = 14), bruising (8), and erythema (5) being the most common. Incisional discharge was not observed in any of the dogs on day 1.

Table 1—Numbers and percentages of incisions (n = 125) grouped by patient sex and neuter status for 113 dogs undergoing unilateral (101) or bilateral (12) modified closed anal sacculectomies via monopolar electrosurgery between January 2015 and June 2024.

Sex and neuter status (No. of incisions)	No. (%) of incisions with complications	95% CI	No. (%) of incisions without complications	95% CI
Spayed females (37)	2 (11)	2–35	35 (33)	24–43
Castrated males (83)	17 (89)	66–98	66 (62)	52–71
Intact females (0)	0 (0)	0–21	0 (0)	0–4
Intact males (5)	0 (0)	0–21	5 (5)	2–11

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Incisional complications at postoperative examination

The median length of the total postoperative period was 15 days (IQR, 14.5 to 17 days; range, 10 to 30 days). The median day of first detection of complications was day 4 (IQR, 2.5 to 7 days; range, 2 to 8 days). Complications were detected for 11 incisions (9%) on postoperative examination. By use of the ASGS scale,[25] 8 incisions had grades above zero. Four incisions were grade 1, 1 incision was grade 2, and 3 incisions were grade 3 **(Supplementary Table S1)**. By use of the VCOG scale,[26] 3 incisions were grade 1, 5 incisions were grade 2, and 3 incisions were grade 3. Eight of these incisions required treatment for incisional dehiscence, with 3 incisions (all grade 3) requiring surgical revision of the incision. One incision had dehiscence at the proximal and distal ends of the incision. The dog was sedated and had additional skin sutures placed. Another incisional dehiscence was suspected to be secondary to trauma due to excessive scooting at home. All external skin sutures were absent, and superficial incisional dehiscence was present along the entire incision. The dog was sedated and had additional skin sutures placed. The third incision dehisced through the skin and subcutaneous tissues. The dog was sedated and had additional interrupted sutures placed within the subcutaneous layer and skin. The other 5 incisions were treated with oral antibiotics and/or topical therapies and healed by second intention. Two incisions were originally prescribed cefpodoxime postoperatively and were switched to amoxicillin–clavulanic acid at 13.75 mg/kg twice daily for 2 weeks. One incision healed after the client was instructed to gently flush the dehisced region with warm water 3 times daily at home and continue standard postoperative care. Two incisions healed by second intention with no additional therapies indicated. No cultures were obtained for any suspected incisional infections, as clients declined this diagnostic when offered. Only one of the incisions that required treatment for dehiscence experienced postoperative diarrhea. The most common types of postoperative complications were dehiscence (n = 8), incisional discharge (4), transient fecal incontinence (3), scooting (2), erythema (1), and bruising (1).

Anal sac lesion size and postoperative complications

One hundred fourteen incisions treated neoplastic anal sac lesions. Maximal diameters of anal sac lesions were collected from imaging reports for 108 incisions. One lesion was a primary re-excision of a previous anal sacculectomy scar, so no diameter was recorded. Four incisions (50%) treated large (> 5-cm maximal diameter) anal sac lesions and had incisional complications on day 1 compared to 11 incisions (11%) that treated small (≤ 5-cm maximal diameter) anal sac lesions. Large anal sac lesions were associated with complications on day 1 (P = .02). No significant associations were found between anal sac lesion size and day 1 postoperative complications (P = .72).

Eight incisions (8%) treated large anal sac lesions, none of which experienced incisional complications upon postoperative examination. Ninety-eight incisions (96%) treated small lesions, 4 (4%) of which had incisional complications upon postoperative examination. No significant associations between anal sac lesion size and incisional complications were found within the postoperative period (P = .36).

Weight and postoperative complications

Eighty incisions were performed in dogs that weighed > 15 kg, and 45 incisions were performed in dogs that weighed ≤ 15 kg. Day 1 complications were found in 14 incisions (80%) in dogs that weighed > 15 kg and 5 incisions (11%) in dogs that weighed ≤ 15 kg. Within the postoperative period, 4 incisions (5%) in dogs weighing > 15 kg and 1 incision (2%) in dogs weighing ≤ 15 kg had postoperative complications. No significant associations were found between weight and postoperative complications (P = .65).

Diarrhea and postoperative incisional status

Nine incisions (7%) were in dogs that had preoperative diarrhea; none had postoperative complications. Of the 116 incisions (93%) in dogs that did not have preoperative diarrhea, 11 incisions (9%) had complications. No associations between preoperative diarrhea and postoperative complications were found (P > .99). Thirty-six incisions (29%) were in dogs that had postoperative diarrhea; of these, 5 incisions (14%) had postoperative complications. Eighty-nine incisions (86%) were in dogs that did not have postoperative diarrhea; of these, 6 (7%) had postoperative complications. No significant associations between pre- or postoperative diarrhea and postoperative complications were found (P = .29).

Postoperative complications and neoplasia

Among 109 incisions that treated neoplasia, 16 (15%) were incompletely excised **(Table 2)**. No association between postoperative complications and incomplete excision (P > .99) or between postoperative complications and the presence of neoplasia (P = .36) was detected **(Table 3)**.

Table 2—Postoperative complications versus neoplasia excision status in 109 monopolar cautery dissection incisions via a modified closed anal sacculectomy technique. No significant difference was found (P > .99).

	No. (%) of incomplete excisions	95% CI	No. (%) of complete excisions	95% CI
Complications (n = 11)	1 (6)	0–32	10 (11)	6–19
No complications (n = 98)	15 (94)	68–100	83 (89)	91–94

Table 3—Postoperative complications for neoplastic and nonneoplastic lesions in 125 monopolar cautery dissection incisions via a modified closed anal sacculectomy technique. No significant difference was found (P = .36).

	No. (%) with complications	95% CI	No. (%) without complications	95% CI
Neoplasia (n = 109)	11 (100)	68–100	98 (86)	78–92
Nonneoplasia (n = 16)	0 (0)	0–32	16 (14)	8–22

Discussion

A total of 125 incisions and dissections were performed with the use of electrosurgery. Thirty-two experienced postoperative complications: 15% at day 1 and 9% during the postoperative period. Previous studies[15-18] evaluating the modified closed approach to anal sacculectomy have reported postoperative complication rates of 6% to 42%. Our cohort's complication rate was similar to previously reported complication rates, although different postoperative complication grading schemes were utilized between studies. Within this study, 2 postoperative grading schemes were used: the ASGS scale[28] to allow comparison to previous anal sacculectomy studies, and the VCOG scale[29] to allow comparison to future oncologic investigative studies. Both scales have similar grading schemes, but grade 1 within the ASGS scale[28] requires a minor procedure to address the postoperative complication, while the VCOG scale[29] does not. Thus, postoperative complication grades were generally higher with the VCOG scale.[29] Postoperative complication rates for other surgical approaches to anal sacculectomy have ranged from 15% to 36%,[12-14,31] with lower complication rates reported for traditional closed approaches than for traditional open approaches.[8] Further prospective studies are warranted to determine the direct comparison of postoperative complications between the different approaches.

Electrosurgery may minimize the occurrence of swelling, bruising, and erythema during the postoperative period due to the rapid sealing of lymphatics and blood vessels.[21-24] These complications were detected most frequently at day 1 in this study but were minimally detected during the postoperative period, suggesting low rates of complications. However, electrosurgery is used cautiously for incisions due to the concern that thermal energy may increase the risk of devitalized tissue, increasing the risk of infection and delayed wound healing.[20] A study by Meakin et al[24] evaluated the use of electrosurgery for abdominal incisions in dogs and reported normal healing for all incisions and no complications. In contrast, a study by Scott et al[20] found that although electrosurgical incisions improved erythema and hemostasis, histologic evaluation revealed larger wounds compared to cold steel. However, the incisions were only evaluated at 7 days postoperatively and complete wound healing was not evaluated.[20] These findings suggest that electrosurgical incisions may cause greater histologic changes compared to cold steel, but this result may not represent gross healing. Further research is needed to fully assess the use of electrosurgery and its influence on incisional healing.

Studies utilizing cold steel for incisional approach reported mild postoperative complications between 6% and 32%.[15-17] In a study by Davey et al,[16] the most commonly reported complication was dehiscence (23%). Dehiscence was subdivided into healing by second intention (19%) and surgical revision (4%). Our cohort had a similar rate of dehiscence (6%). A study by Fontes et al[17] reported a postoperative complication rate of 14%, with dehiscence requiring open wound management being the most common. A study by Davis et al[18] investigated nonneoplastic anal sac disease and utilized electrosurgery for incision and cold steel for dissection. The authors of that study reported a postoperative complication rate of 42%, which is higher than the present study's postoperative complication rate of 9%.[18] This higher postoperative complication rate may be due to a higher incidence of excessive scooting during the postoperative period (14%) and inflammatory conditions of the anal sac lesions. Anal sacculitis accounted for 62% of the lesions and anal sac abscessation accounted for 22%. Nonneoplastic anal sac lesions were a much smaller proportion of this study's cohort (13%), limiting direct comparisons.

For large AGASACAs in dogs, a postoperative complication rate of 36% has been reported, with transient fecal incontinence and diarrhea being the most common.[12] Within this study's cohort, there were 8 incisions with large neoplastic lesions, all diagnosed as AGASACA on histopathology. Four of these incisions experienced postoperative complications on day 1 (swelling and bruising), but these self-resolved and had no further complications within the postoperative period. Electrosurgery may help reduce these complications, as it has been shown to minimize blood loss, which may have pronounced effects in large tumors with highly vascularized tumor beds.[32] It has been reported that removal of > 50% of the external anal sphincter can cause permanent fecal incontinence.[12] However, permanent fecal incontinence is reported to be rare,[8,12-14,31] with transient fecal incontinence reported between 2% and 15%.[12-15,31] Within this cohort, 3 incisions (2%) treating small anal sac lesions reported transient fecal incontinence, all of which resolved by incisional examination. The exact duration of fecal incontinence was not recorded within the medical records. A study by Griffin et al[12] evaluating the removal of large AGASACAs reported that 14% of their cohort had transient fecal incontinence postoperatively; none reported permanent fecal incontinence. For our incisions that treated large anal sac lesions, none reported transient or permanent fecal incontinence. A previous study[33] evaluating bilateral anal sacculectomy reported only 1 out of 35 dogs with transient fecal incontinence. Within that study, all postoperative complications were self-limiting and reported at 54%, with swelling at the surgical site and loose stools being the most commonly reported complications. Charlesworth et al[13] found that bilateral anal sacculectomy may damage a greater proportion of the anal sphincter and increase the risk of transient fecal incontinence, especially in dogs weighing < 15 kg due to the closer proximity of the caudal rectal nerve to the anal sacs and/or the greater proportion of the anal sphincter that is dissected.[13] Within our cohort, 12 dogs had bilateral anal sacculectomy performed but there was only 1 report of transient fecal incontinence from a dog weighing < 15 kg. The most commonly reported day 1 complication was bruising and swelling. Within the postoperative period, 1 incision dehisced each in 2 different dogs. In one dog,

the incision healed by second intention with no additional therapies, and the other dog was switched to amoxicillin–clavulanic acid and the incision healed by second intention. This supports the rarity of permanent fecal incontinence following the excisions of large or bilateral anal sac lesions. However, the prevalence of large or bilateral anal sac lesions was low in this study, which may limit broad conclusions.

The presence of neoplasia can alter wound healing,[34,35] but no association was found within this study. Furthermore, our cohort found a recurrence rate of 9%, with incomplete excision being significantly more likely to develop recurrence. Only 2 incisions that developed local recurrence had a large anal sac lesion, but surgical excisions were complete. Dogs with more aggressive disease may inherently make complete excision difficult, thus making recurrence more likely, although this study did not evaluate histopathology reports for how narrow the surgical margins were or the presence of angiolymphatic invasion. The local recurrence rate of AGASACA has been reported at 5% to 39%.[12,14,17,31,36] Previous studies[15,16] evaluating the use of the modified closed approach have reported a generally lower local recurrence rate of 2% to 13%. Although, a recent study[17] reported a higher local recurrence rate of 23% and found no difference in local recurrence when comparing the traditional closed approach to the modified closed approach. The median time to detection of local recurrence in this study was 343 days, which was comparable to the reported range of 90 to 786 days.[12,14,17,31,36] Further studies are warranted to evaluate the impact of electrosurgery on local recurrence.

The presence of diarrhea, preoperatively or postoperatively, showed no association with postoperative complications. Due to the intimate association of the perianal incision and fecal material, diarrhea is a significant risk for incisional infection. All patients were prescribed postoperative antibiotics and directed to apply zinc oxide paste (Desitin) to the incision during the postoperative period, which may have minimized the risk of infection by minimizing the bacterial load exposed to the incision. Due to the clean-contaminated nature of the surgery, perioperative antibiotics are recommended for all patients; however, previous studies[37,38] have shown that postoperative antibiotics may not be indicated for all clean-contaminated surgeries. Decisions on their use should be determined on signs of concurrent infection (such as pyoderma at the time of surgery) or patient comorbidities.[37,38] Another limitation of this study was that antibiotics were changed without culture and sensitivity testing. This process does not align with current antimicrobial stewardship guidelines,[39] as the use of higher-generation antibiotics (such as Clavamox and enrofloxacin) should only be used on the basis of culture and sensitivity results. Furthermore, postoperative diarrhea was treated with a short course of metronidazole. Recent guidelines no longer recommend the use of metronidazole as a first-line treatment option for acute diarrhea due to concerns for gastrointestinal dysbiosis and antibiotic stewardship.[39,40] First-line treatments include probiotics and diet modification.[40] Although

diarrhea was not shown to have any association with postoperative complications, it is still recommended to promptly treat diarrhea to minimize the risk of surgical site infection.

This study had several additional limitations. The retrospective nature of the study relied on medical records, which lacked standardization between evaluators and clinics. This limitation was mitigated by ensuring that dogs with postoperative complications were evaluated at the study hospital and excluding dogs that were lost to follow-up from the study. Surgeries were also performed by 2 surgeons from a single veterinary hospital, so generalizations to the larger population may be limited. Another limitation was the wide range of follow-up (14 to 2,278 days) for dogs when we evaluated for local recurrence of AGASACA. Restaging (thoracic radiographs, abdominal ultrasound, physical examination, and rectal examination) was recommended for all patients every 3 to 4 months for 18 months and then every 6 months following but was largely reliant on client compliance, so local recurrence may be underestimated. The use of adjunctive therapies and its influence of local recurrence was beyond the scope of this study. Antibiotic use may have also influenced postoperative complications. Direct comparison of the complication rates of electrosurgery versus cold steel was beyond the scope of this study, but further clinical studies are warranted. However, this study was a first step toward exploring the complications and risk factors of using electrosurgery when performing anal sacculectomy.

In conclusion, the use of monopolar electrosurgery for both incision and dissection did not alter the rate of postoperative complications when anal sacculectomy was performed with the use of the modified closed approach. The weight of the dog, presence of diarrhea, presence of neoplasia, size of neoplastic anal sac lesions, and excision status were not associated with postoperative complications. All incisions healed without major complications, and most postoperative complications were self-limiting or only required medical management. Local recurrence rates of AGASACA were comparable to those of previous studies evaluating the modified closed approach to anal sacculectomy. Therefore, the use of electrosurgery can be considered for incision and dissection in the modified closed approach for anal sacculectomy.

References
1. Berrocal A, Vos J, van den Ingh TS, Molenbeek R, Van Sluijs F. Canine perineal tumours. *Zentralbl Veterinarmed A*. 1989;36(10):739–749. doi:10.1111/j.1439-0442.1989.tb00787.x

2. Withrow SJ, Vail DM, Thamm DH, Liptak JM, eds. *Withrow & MacEwen's Small Animal Clinical Oncology.* 6th ed. Saunders Elsevier; 2020:468.

3. Mendez Valenzuela CR, Shin K, Weng HY, Plantenga JM, Vanhaezebrouck IF. Radiotherapy for canine apocrine gland anal sac adenocarcinoma: survival outcomes and side effects of a palliative treatment protocol of 20 Gy in five consecutive fractions. *Vet Sci*. 2024;11(5):219. doi:10.3390/vetsci11050219

4. Potanas CP, Padgett S, Gamblin RM. Surgical excision of anal sac apocrine gland adenocarcinomas with and without adjunctive chemotherapy in dogs: 42 cases (2005–2011). *J Am Vet Med Assoc*. 2015;246(8):877–884. doi:10.2460/javma.246.8.877

5. Lundberg A, Koch SN, Torres SMF. Local treatment for canine anal sacculitis: a retrospective study of 33 dogs. *Vet Dermatol*. 2022;33(5):426–434. doi:10.1111/vde.13102

6. Corbee RJ, Woldring HH, van den Eijnde LM, Wouters EGH. A cross-sectional study on canine and feline anal sac disease. *Animals (Basel)*. 2021;12(1):95. doi:10.3390/ani12010095

7. Hvitman-Graflund K, Sparks T, Varjonen K. A retrospective study of treatment, outcome, recurrence and concurrent diseases in 190 dogs with anal sacculitis. *Vet Dermatol*. 2023;34(6):576–585. doi:10.1111/vde.13205

8. Hill LN, Smeak DD. Open versus closed bilateral anal sacculectomy for treatment of non-neoplastic anal sac disease in dogs: 95 cases (1969–1994). *J Am Vet Med Assoc*. 2002;221(5):662–665. doi:10.2460/javma.2002.221.662

9. Ragni RA. Anal sac disease and its surgical treatment. *Companion Anim*. 2012;17(6):17–25. doi:10.1111/j.2044-3862.2012.00201.x

10. Diaz D, Boston S, Ogilvie A, Singh A, Skinner O. Modified balloon-catheter-assisted closed anal sacculectomy in the dog: description of surgical technique. *Can Vet J*. 2019;60(6):601–604.

11. Baines SJ, Aronson LR. Rectum, anus, and perineum. In: Johnston SA, Tobias KM, eds. *Veterinary Surgery: Small Animal Expert Consult*. 2nd ed. Elsevier; 2018:1808–1809.

12. Griffin MA, Mayhew PD, Culp WTN, et al. Short- and long-term outcomes associated with anal sacculectomy in dogs with massive apocrine gland anal sac adenocarcinoma. *J Am Vet Med Assoc*. 2023;261(10):1–8. doi:10.2460/javma.22.12.0592

13. Charlesworth TM. Risk factors for postoperative complications following bilateral closed anal sacculectomy in the dog. *J Small Anim Pract*. 2014;55(7):350–354. doi:10.1111/jsap.12217

14. Barnes DC, Demetriou JL. Surgical management of primary, metastatic and recurrent anal sac adenocarcinoma in the dog: 52 cases. *J Small Anim Pract*. 2017;58(5):263–268. doi:10.1111/jsap.12633

15. Chen CL, Lapsley JM, Selmic LE. Minimal complications observed with a modified surgical approach for treatment of canine anal sac neoplasia. *J Am Vet Med Assoc*. 2021;260(S1):S59–S64. doi:10.2460/javma.21.01.0008

16. Davey EL, Prpich CY. Outcomes of dogs with apocrine gland anal sac adenocarcinoma treated via modified closed anal sacculectomy (2015-2022). *Vet Surg*. 2024;53(6):973–979. doi:10.1111/vsu.14084

17. Fontes GS, McGrath AM, Chen CL, et al. Long-term outcomes associated with a modified versus traditional closed anal sacculectomy for treatment of canine anal sac neoplasia. *J Am Vet Med Assoc*. 2023;261(11):1–7. doi:10.2460/javma.23.05.0239

18. Davis AT, Hosgood GL. Modified closed sacculectomy in 50 dogs with non-neoplastic anal sac disease. *Vet Surg*. 2025;54(2):382–388. doi:10.1111/vsu.14168

19. Munro MG. Fundamentals of electrosurgery part I: principles of radiofrequency energy for surgery. In: Feldman L, Fuchshuber P, Jones DB, eds. *The SAGES Manual on the Fundamental Use of Surgical Energy (FUSE).* Springer; 2012:15–59. doi:10.1007/978-1-4614-2074-3_2

20. Scott JE, Swanson EA, Cooley J, Wills RW, Pearce EC. Healing of canine skin incisions made with monopolar electrosurgery versus scalpel blade. *Vet Surg*. 2017;46(4):520–529. doi:10.1111/vsu.12650

21. Aird LN, Brown CJ. Systematic review and meta-analysis of electrocautery versus scalpel for surgical skin incisions. *Am J Surg*. 2012;204(2):216–221. doi:10.1016/j.amjsurg.2011.09.032

22. Kearns SR, Connolly EM, McNally S, McNamara DA, Deasy J. Randomized clinical trial of diathermy versus scalpel incision in elective midline laparotomy. *Br J Surg*. 2001;88(1):41–44. doi:10.1046/j.1365-2168.2001.01625.x

23. Prakash LD, Balaji N, Kumar SS, Kate V. Comparison of electrocautery incision with scalpel incision in midline abdominal surgery: a double blind randomized controlled trial. *Int J Surg*. 2015;19:78–82. doi:10.1016/j.ijsu.2015.04.085

24. Meakin LB, Murrell JC, Doran ICP, Knowles TG, Tivers MS, Chanoit GPA. Electrosurgery reduces blood loss and immediate postoperative inflammation compared to cold instruments for midline celiotomy in dogs: a randomized controlled trial. *Vet Surg*. 2017;46(4):515–519. doi:10.1111/vsu.12641

25. Lee SG, Jeong SM, Bae S, Park Y, Moon C, Kim HY. Inside-out anal sacculectomy in small dog breeds and cats. *Front Vet Sci*. 2023;10:1105826. doi:10.3389/fvets.2023.1105826

26. Smeak DD. Anal sac resection*.* In: Monnet E, Smeak DD, eds. *Gastrointestinal Surgical Techniques in Small Animals*. John Wiley & Sons; 2020:257–262.

27. Schlag AN, Johnson T, Vinayak A, Kuvaldina A, Skinner OT, Wustefeld-Janssens BG. Comparison of methods to determine primary tumour size in canine apocrine gland anal sac adenocarcinoma. *J Small Anim Pract*. 2020;61(3):185–189. doi:10.1111/jsap.13104

28. Strasberg SM, Linehan DC, Hawkins WG. The accordion severity grading system of surgical complications. *Ann Surg*. 2009;250(2):177–186. doi:10.1097/SLA.0b013e3181afde41

29. LeBlanc AK, Atherton M, Bentley RT, et al. Veterinary Cooperative Oncology Group-Common Terminology Criteria for Adverse Events (VCOG-CTCAE v2) following investigational therapy in dogs and cats. *Vet Comp Oncol*. 2021;19(2):311–352. doi:10.1111/vco.12677

30. *R: A Language and Environment for Statistical Computing*. Version 4.4.1. The R Foundation for Statistical Computing; 2024. Accessed August 28, 2024. https://www.R-project.org/

31. Sterman A, Butler JR, Chambers A, et al. Post-operative complications following apocrine gland anal sac adenocarcinoma resection in dogs. *Vet Comp Oncol*. 2021;19(4):743–749. doi:10.1111/vco.12748

32. Katayama Y, Uchino J, Chihara Y, et al. Tumor neovascularization and developments in therapeutics. *Cancers (Basel)*. 2019;11(3):316. doi:10.3390/cancers11030316

33. Franca A, Stamenova P, Thompson JL. Histopathological diagnosis and surgical complications following bilateral anal sacculectomy for the treatment of unilateral canine apocrine gland anal sac adenocarcinoma: 35 cases (2019-2023). *J Small Anim Pract*. 2024;65(6):394–401. doi:10.1111/jsap.13731

34. Kudo A, Yoshimoto S, Yoshida H, Izumi Y, Takagi S. Biological features of canine cancer-associated fibroblasts and their influence on cancer cell invasion. *J Vet Med Sci*. 2022;84(6):784–791. doi:10.1292/jvms.22-0041

35. Yoshimoto S, Hoshino Y, Izumi Y, Takagi S. α-Smooth muscle actin expression in cancerassociated fibroblasts in canine epithelial tumors. *Jpn J Vet Res*. 2017;65(3):135–144. doi:10.14943/jjvr.65.3.135

36. Skorupski KA, Alarcón CN, de Lorimier LP, LaDouceur EEB, Rodriguez CO, Rebhun RB. Outcome and clinical, pathological, and immunohistochemical factors associ-

ated with prognosis for dogs with early-stage anal sac adenocarcinoma treated with surgery alone: 34 cases (2002–2013). *J Am Vet Med Assoc*. 2018;253(1):84–91. doi:10.2460/javma.253.1.84

37. Eugster S, Schawalder P, Gaschen F, Boerlin P. A prospective study of postoperative surgical site infections in dogs and cats. *Vet Surg*. 2004;33(5):542–550. doi:10.1111/j.1532-950X.2004.04076.x

38. Turk R, Singh A, Weese JS. Prospective surgical site infection surveillance in dogs. *Vet Surg*. 2015;44(1):2–8. doi:10.1111/j.1532-950X.2014.12267.x

39. Frey E, Costin M, Granick J, Kornya M, Weese JS. 2022 AAFP/AAHA Antimicrobial Stewardship Guidelines. *J Am Anim Hosp Assoc*. 2022;58(4):1–5. doi:10.5326/1547-3317-58.4.1

40. Jessen LR, Werner M, Singleton D, et al. European Network for Optimization of Veterinary Antimicrobial Therapy (ENOVAT) guidelines for antimicrobial use in canine acute diarrhoea. *Vet J*. 2024;307:106208. doi:10.1016/j.tvjl.2024.106208

Supplementary Materials

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