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Outcomes associated with vaginectomy and vulvovaginectomy in 21 dogs

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Abstract

Objective: To report the outcomes of dogs with lesions of the genitourinary tract treated by vaginectomy or vulvovaginectomy.

Study design: Multi-institutional retrospective study.

Animals: Female dogs that underwent vulvovaginectomy, complete vaginectomy, or subtotal vaginectomy from 2003 to 2018 with complete medical records and a minimum of 60 days follow-up.

Methods: Data collected from medical records included preoperative, intraoperative, and postoperative data, such as the occurrence of urinary incontinence (UIC), disease recurrence, and death/euthanasia.

Results: This study included 21 dogs. Four dogs had vulvovaginectomy, six had complete vaginectomy, and 11 had a subtotal vaginectomy performed. The mean age at surgery was 9.2 years (SD, 3.3). Thirteen dogs were intact at presentation. Smooth muscle tumors were diagnosed most commonly (10 leiomyomata, three leiomyosarcomas, two leiomyofibromas). The median duration of follow-up was 520 days (range, 71-1955). Major complications requiring revision surgery were recorded in two dogs. Postoperative UIC occurred in six of 21 dogs, resolving

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spontaneously within 60 days in three dogs. Dogs with malignant tumors (n = 6) survived at least 71 days (median, 626; 95% CI, 71-1245), and recurrence of disease occurred in two dogs. In dogs with benign tumors (n = 15), the median survival time was not reached. These dogs survived at least 104 days and had no recurrence of the disease.

Conclusion: Vaginectomy and vulvovaginectomy resulted in prolonged survival and low rates of major complications and UIC.

Clinical significance: This study provides evidence to recommend that the risks of this procedure and expectations should be discussed with clients.

1 | INTRODUCTION

Vaginal and vulvar tumors account for 2.5% to 3.0% of neoplasms affecting dogs.[1,2] Among these, most are benign (73%–94%), with leiomyoma being the most commonly diagnosed.[1,3] Benign tumors are more frequently pedunculated, and marginal excision via exteriorization or episiotomy is often feasible.[1,2] Malignant tumors, such as leiomyosarcomas, adenocarcinomas, and mast cell tumors (MCT), have a greater tendency to be nonpedunculated. These tumors require larger surgical margins, often requiring a more aggressive surgical approach for curative-intent surgery.[1,2] Vulvovaginectomy, complete vaginectomy, and subtotal vaginectomy are employed when wide margins are required for resection of neoplasia in the caudal reproductive or urinary tracts of female dogs.[4]

Vulvovaginectomy involves the removal of the entire vagina, vestibule, and vulva, along with a portion of the distal urethra. The remaining distal urethra is then spatulated, and the urethral mucosa is sutured to the skin to form a perineal urethrostomy.[3] A complete vaginectomy removes all vaginal tissue to the level of the vestibule. This procedure may require reimplantation of the urethra, depending on the location and extent of the lesion. A subtotal vaginectomy is similar to complete vaginectomy, but a segment of vaginal tissue is left in situ (Figure 1). For spayed females, the uterine stump is removed with the cervix during vulvovaginectomy and complete vaginectomy.[1,4] In intact bitches, concurrent ovariohysterectomy should be performed with both of these procedures.[1,4] Ovariohysterectomy at the time of surgery decreases the risk of recurrence for benign lesions, but whether there is benefit for malignancies is unknown.[1,4] Information regarding postoperative complications or outcomes in dogs treated with subtotal or complete vaginectomy or vulvovaginectomy is sparse.[3,5,6] Subtotal vaginectomy was most recently described in 11 dogs.[7] Urinary incontinence (UIC) has been described as a complication of these procedures,[3] but the frequency with which this occurs is not known. Possible mechanisms could include disruption of local innervation, loss of urethral resistance, hormonal influence, or other factors. Other complications, such as urinary tract infections (UTI), dehiscence, and infection, may occur in dogs after subtotal vaginectomy, complete vaginectomy, or vulvovaginectomy.

To the best of the authors' knowledge, outcomes in canine vaginectomy and vulvovaginectomy have not been assessed in a multi-institutional case series. The objective of this study was to report outcomes in dogs that underwent subtotal vaginectomy, complete vaginectomy, or vulvovaginectomy for genitourinary lesions, including the nature and frequency of postoperative complications and disease recurrence. Our hypothesis, based on clinical experience, was that procedures would be well tolerated with a low rate of major postoperative complications and permanent UIC and that dogs would experience long-term survival.

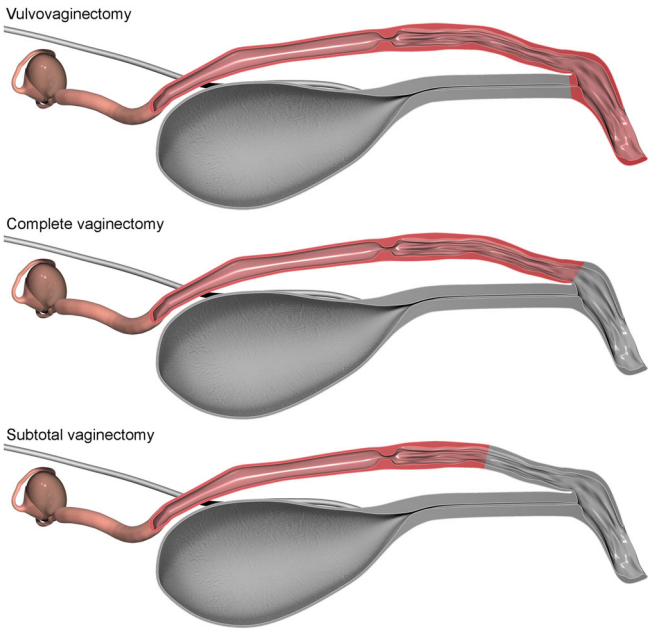

FIGURE 1 Illustration of the degree of tissue removed (pink) with (from top to bottom) vulvovaginectomy, complete vaginectomy, and subtotal vaginectomy. Illustration used with permission of The Ohio State University

2 | MATERIALS AND METHODS

2.1 | Study procedures

A multi-institutional retrospective case series was performed because of the low frequency of lesions of the caudal reproductive tract requiring surgical treatment. Participating institutions included six academic veterinary medical centers and one private practice (The Ohio State University Veterinary Medical Center; Alta Vista Animal Hospital, VCA Canada; Companion Animal Hospital, Ontario; Veterinary College, University of Guelph; UC Davis William R. Pritchard Veterinary, Medical Teaching Hospital; University of Florida Small Animal Hospital; Veterinary Teaching Hospital University ofGeorgia; North Carolina State Veterinary Hospital, Angell Animal Medical Center). Medical record searches were performed at each institution to identify dogs that underwent subtotal vaginectomy, total vaginectomy, or vulvovaginectomy for the treatment of masses affecting the genitourinary tract between July 1, 2003 and July 31, 2018. For inclusion, dogs' complete medical records were required, including surgical reports, histopathology results, and documentation of clinical follow-up at the contributing center or referring veterinarian. When a veterinarian had not recently assessed the dog, owner follow-up was attempted. Retrospective owner communications were also included when necessary, such as in cases of deceased dogs. Additional inclusion criteria included a minimum follow-up of 60 days after surgery to allow for recovery and completed healing, followed by a return to regular activity. Exclusion criteria were incomplete medical records, loss to follow-up before 60 days postoperatively, dogs undergoing vulvectomy alone or routine ovariohysterectomy alone, and dogs undergoing the procedure for reasons other than suspected neoplasia (eg, intersex conditions).

Each institution performed a medical record review. Baseline data collected included age at the time of surgery, breed, neuter status, and primary presenting complaint(s). Other preoperative data recorded included results from any imaging studies, cytology, histopathology, complete blood counts, biochemical profiles, urinalysis, urine cultures, or additional testing performed. Intraoperative data collected included the procedure performed and any complications encountered during the procedure. Postoperative data recorded included histopathologic diagnosis, complications, local recurrence, development of metastasis, date at last follow-up or euthanasia/death, and cause of death or euthanasia when applicable and available.

A complication was defined as an adverse event associated with surgical intervention.[8] Intraoperative complications occurred between skin incision and skin closure, and postoperative complications occurred after skin closure.[8] Complications were classified as major when a second surgical intervention was pursued to address the complication and minor when no additional surgical intervention was required. Urinary incontinence was scored retrospectively in all dogs by the contributing authors using a scoring system scale of 1 to 10.[9] A score of 1 signified that a dog was minimally continent or extremely incontinent (leaking urine all the time); a score of 5 signified that a dog was moderately continent (leaking urine only when lying down or when the urinary bladder was full but able to hold some urine between urinations); and a score of 10 signified that a dog was perfectly continent with no urine leakage. These scores were assigned according to the clinical progress notes available at either the contributing institution or the referring veterinarian. Scores were assigned at 10 to 20 days postoperatively to reflect the status at the initial incision recheck, at 60 days postoperatively to allow for completed recovery and return to function, and at the time of final follow-up.

2.2 | Statistical analysis

Descriptive statistics were calculated in SAS Version 9.4 for Windows (SAS Institute, Cary, North Carolina). Continuous variables were assessed for normality by using skewness, kurtosis, and Shapiro–Wilk tests. Normally distributed continuous variables were described with mean and SD. Nonnormally distributed continuous variables were presented as median and interquartile range. Frequencies were used to describe categorical variables.

The overall survival time (OST) was calculated as the number of days from the date of surgery to the date of death or euthanasia or loss to follow-up. Overall survival time was calculated separately for benign and malignant lesions. Dogs were censored in the overall survival analysis when the dog was alive at last follow-up. Kaplan–Meier methodology was used to draw survival curves and calculate the median OST with the 95% CI.

3 | RESULTS

3.1 | Demographics

Twenty-seven cases were reviewed, but only 21 dogs met inclusion criteria. Reasons for exclusion were loss to follow-up before 60 days postoperatively, incomplete medical records, or lack of a qualifying surgical procedure. Descriptive statistics are presented for the

whole study population and not were stratified by procedure because of the low numbers of dogs in each category.

The mean age at the time of surgery was 9.2 years (SD, 3.3), and 13 of 21 females were intact at the time of presentation. Ovarian remnants were present in three previously spayed dogs, with these dogs considered intact due to hormone status (Table 1). Breeds represented included mixed breed dogs (n = 5), golden retriever (n = 3), Shetland sheepdog (n = 2), German shepherd (n = 2), border collie (n = 2), and seven other breeds.

3.2 | Clinical findings

The most common clinical sign at presentation was vaginal bleeding or discharge (n = 12). Tenesmus and dysuria were exhibited by five and three dogs, respectively. A mass was visible (n = 4) or palpable (n = 3) in seven dogs. The tumor was identified incidentally at physical examination in two dogs that had no associated clinical signs. Other presenting clinical signs included UIC (n = 2), an unexpected heat cycle in a previously spayed female (n = 1), and irregular heat cycles in an intact female (n = 1).

Preoperative diagnostics included lesion cytology (n = 5) and histopathology (n = 9; Table 1). Urinalysis was performed preoperatively in 11 dogs (Table 2). Only four of these 11 dogs had preoperative urine cultures; results of all four cultures were negative for bacterial growth. No relevant abnormalities were found in 20 and 14 dogs that had a complete blood count and a biochemical panel, respectively. Preoperative diagnostic imaging included abdominal ultrasound (n = 9), thoracic radiography (n = 15), thoracic computed tomography (CT; n = 3), and abdominal CT (n = 11). More than one imaging modality was used for multiple dogs. Dogs 7 and 14 had excretory urograms with concurrent vaginograms, and vaginal masses with no other concurrent abnormalities were diagnosed. Dogs 5 and 6 did not have any imaging studies performed. A 3- to 4-mm pulmonary nodule was noted on thoracic radiographs in dog 16; additional imaging with thoracic CT confirmed this to be an osteoma as well as confirming the presence of other osteomas. In dog 20, liver and splenic nodules were observed on abdominal CT images; these nodules were aspirated preoperatively, and records noted that cytology was not concerning for metastatic disease. However, exact cytologic findings were not retrievable.

Seven dogs had concurrent masses, and the details of location and cytologic diagnosis, when available, are in Table 1. Because of location, appearance on imaging, or subsequent removal and histopathology, it was determined that none of these additional masses represented metastatic lesions. Specifically, no dogs with malignant tumors (n = 6) had overt metastases noted on preoperative staging, including thoracic imaging (6/6) and abdominal imaging (5/6).

3.3 | Surgery

Tumors were excised via vulvovaginectomy in four dogs, total vaginectomy in six dogs, and subtotal vaginectomy in 11 dogs. Concurrent episiotomy for exposure of the mass was performed in six dogs; four of these dogs had subtotal vaginectomies, and two dogs had complete vaginectomies. Concurrent ovariohysterectomy was performed in nine dogs (subtotal vaginectomy = 5, complete vaginectomy = 2, vulvovaginectomy = 2). Ovarian remnants were excised in three dogs (subtotal vaginectomy = 1, complete vaginectomy = 1, vulvovaginectomy = 1). Dog 11 was intact at the time of presentation and had a subtotal vaginectomy performed but did not undergo concurrent ovariohysterectomy per owner request.

3.4 | Histologic diagnoses

Preoperative histopathology was consistent with the final postoperative histopathology in seven of nine dogs (Table 1). For two dogs (dogs 20 and 21), preoperative findings were discordant with postoperative histopathology. Leiomyosarcoma was diagnosed preoperatively in dog 20, and a leiomyoma was discovered at final postoperative histopathology. A smooth muscle tumor was diagnosed preoperatively in dog 21, and a fibrosarcoma was discovered at postoperative histopathology. The most common histopathological diagnoses consisted of leiomyoma (10 dogs), leiomyosarcoma (three dogs), and leiomyofibroma (two dogs). Among the dogs with leiomyoma, three of 10 had been previously spayed, while seven of 10 were hormonally intact at the time of presentation. Both dogs who developed leiomyofibromas were intact. A sarcoma that was either a leiomyosarcoma or rhabdomyosarcoma was diagnosed in dog 4; owners declined immunohistochemistry (IHC) to determine cell origin definitively. Fibroma, fibrosarcoma, urothelial carcinoma (UC), and a polyp were diagnosed in four of the remaining five dogs. The proximal vaginal mass in dog 15 was ultimately diagnosed as cervical squamous metaplasia. Completeness of excision for all neoplasms is reported in Table 1. Among the six dogs with concurrent and unrelated neoplasms noted preoperatively, three dogs underwent removal with submission for histopathology, and the other three dogs did not have the masses removed.

TABLE 1 Summary of demographics, cytologic and histopathologic diagnoses, and outcomes in dogs

Dog	Age at time of surgery, y	Sex	Preoperative cytology of the lesion	Preoperative histopathology of the lesion	Comorbidities	Surgical procedure performed	Final histopathologic diagnosis	Histopathologic margins	Alive/dead at time of study	Reason for death or euthanasia	Time to recurrence or metastasis	OST, d	Time from surgery to last follow-up
1	10.1	FI	No	Leiomyofibroma	None	Subtotal vaginectomy	Leiomyofibroma	Not provided by pathologist	Alive	n/a	n/a	527	527
2	7.8	FI	No	No	Allergies	Subtotal vaginectomy	Leiomyoma	Complete excision	Alive	n/a	n/a	975	975
3	5.8	FI	No	No	Ovarian remnants	Subtotal vaginectomy	Leiomyoma	Not provided by pathologist	Alive	n/a	n/a	1955	1955
4	6	FS	Carcinoma	No	Perivulvar mast cell tumor	Subtotal vaginectomy	Sarcoma; leiomyosarcoma or rhabdomyosarcoma, IHC not performed; grade III	Incomplete excision	Dead	Local recurrence	308	583	583
5	3.9	FS	No	No	None	Subtotal vaginectomy	Vaginal lymphoplasmocytic polyp	Complete excision	Alive	n/a	n/a	1265	1265
6	6.1	FI	No	No	None	Subtotal vaginectomy	Leiomyoma	Complete excision	Alive	n/a	n/a	1439	1439
7	7.5	FI	No	No	Heart murmur	Subtotal vaginectomy	Leiomyoma	Complete excision	Dead	Unknown	Unknown	Unknown	104
8	3.5	FI	No	No	None	Subtotal vaginectomy	Leiomyofibroma	Complete excision	Alive	n/a	n/a	189	189
9	7.9	FS	No	Leiomyoma	None	Subtotal vaginectomy	Leiomyoma	Complete excision	Alive	n/a	n/a	690	690
10	10.1	FS	No	Leiomyosarcoma	Hip and stifle osteoarthritis	Subtotal vaginectomy	Leiomyosarcoma, moderately to poorly differentiated	Not provided by pathologist	Dead	Unknown	n/a	1245	1245
11	13.7	FI	No	Polyp or polypoid fibroma	Multiple mammary masses	Subtotal vaginectomy	Fibroma	Complete excision	Dead	Euthanized for senility	n/a	495	495
12	8	FI	No	No	Multiple mammary masses, allergies	Complete vaginectomy	Leiomyoma	None provided by pathologist	Dead	Unknown - no reason noted in rDVM records	n/a	520	520
13	10.8	FS	Urothelial carcinoma	No	None	Complete vaginectomy	Urothelial carcinoma	Complete excision	Dead	Local recurrence	69	71	71
14	13	FS	Nondiagnostic; blood contamination	No	None	Complete vaginectomy	Leiomyoma	Complete excision	Dead	Unknown	n/a	Unknown	147

TABLE 1 (Continued)

Dog	Age at time of surgery, y	Sex	Preoperative cytology of the lesion	Preoperative histopathology of the lesion	Comorbidities	Surgical procedure performed	Final histopathologic diagnosis	Histopathologic margins	Alive/dead at time of study	Reason for death or euthanasia	Time to recurrence or metastasis	OST, d	Time from surgery to last follow-up
15	5	FI	No	No	None	Complete vaginectomy	Cervical squamous metaplasia	Not provided by pathologist	Alive	n/a	n/a	141	141
16	13.9	FS	No	Leiomyoma; previous biopsy of vaginal mass via cystoscopy and previous histopathology from OVH at rDVM	Right adrenal mass, previous low grade ovarian adenocarcinoma	Complete vaginectomy	Leiomyoma	Incomplete excision	Unknown	Unknown	Unknown	Unknown	350
17	11.9	FI	Nondiagnostic; blood contamination	No	Subcutaneous tail base mass	Complete vaginectomy	Leiomyosarcoma	Complete excision	Unknown	Unknown	Unknown	106	106
18	9.8	FS	No	Sarcoma, most consistent with leiomyosarcoma	Obesity	Vulvovaginectomy	Leiomyosarcoma	Incomplete excision	Dead	Unknown	Unknown	827	827
19	11.5	FI	Lipoma	Smooth muscle tumor	Mammary gland tumors, ovarian remnant	Vulvovaginectomy	Leiomyoma	Not provided by pathologist	Alive	n/a	n/a	210	210
20	9	FI	No	Leiomyosarcoma	None	Vulvovaginectomy	Leiomyoma	Not provided by pathologist	Alive	n/a	n/a	450	450
21	12.5	FI	No	Smooth muscle tumor	Right adrenal mass, hypertension, hip dysplasia	Vulvovaginectomy	Fibrosarcoma	Complete excision	Dead	Euthanized for refractory status epilepticus	n/a	626	626

Abbreviations: FI, intact female; FS, spayed female; IHC, immunohistochemistry; n/a, not applicable; OST, overall time from surgery to death; OVH, ovariohysterectomy; rDVM, referring veterinarian.

TABLE 2 Summary of preoperative and postoperative urinary abnormalities in dogs

Dog	Preoperative urinalysis abnormalities	PO UIC	Severity of UIC at 10-20 d PO[a]	Severity of UIC at 60 d PO[a]	Severity of UIC at final follow-up[a]	Duration of UIC	Any treatment attempted for UIC and efficacy	PO urinary tract infection	Urine culture performed	Urine culture results
1	NSF	Yes	10	10	10	2 d	No	No	Yes	No bacterial growth
2	NP	Yes	Not noted	Severity not noted; was incontinent, treated with stilbesterol		No resolution reached	Stilbesterol; improved, grade not given	No	n/a	n/a
3	NP	No	10	10	10	n/a	n/a	No information provided	n/a	n/a
4	NSF	No	10	10	10	n/a	n/a	Yes	Yes	*Staphylococcus pseudintermedius*
5	NP	No	10	10	10	n/a	n/a	No	n/a	n/a
6	Hematuria	No	10	10	10	n/a	n/a	No	n/a	n/a
7	NP	No	10	10	10	n/a	n/a	Yes	Yes	Rare gram-negative rods seen; culture had small numbers of mycoplasma
8	NP	No	10	10	10	n/a	n/a	No	n/a	n/a
9	Hematuria, proteinuria	No	10	10	10	n/a	n/a	No	n/a	n/a
10	NP	No	10	10	10	n/a	n/a	No	n/a	n/a
11	NP	No	10	10	10	n/a	n/a	No	n/a	n/a
12	NSF	No	10	10	10	n/a	n/a	No	n/a	n/a
13	NSF	No	...			n/a	n/a	No	n/a	n/a
14	Hematuria, proteinuria	No straining or leaking, but was intermittently catheterized and then a cystostomy tube was placed and maintained until 147 d PO; normal urination had been noted ~50 d prior			10	~100 d	n/a	Yes	Not noted	n/a
15	NP	No	10	10	10	n/a	n/a	No	n/a	n/a
16	NSF	No	10	10	10	n/a	n/a	No	n/a	n/a
17	NP	No	10	10	10	n/a	n/a	No	n/a	n/a
18	Hematuria, bacteriuria, pyuria	No	10	10	10	n/a	n/a	Yes	Yes	*Enterococcus* spp; *Pseudomonas aeruginosa*

TABLE 2 (Continued)

Dog	Preoperative urinalysis abnormalities	PO UIC	Severity of UIC at 10-20 d PO[a]	Severity of UIC at 60 d PO[a]	Severity of UIC at final follow-up[a]	Duration of UIC	Any treatment attempted for UIC and efficacy	PO urinary tract infection	Urine culture performed	Urine culture results
19	Proteinuria	Yes	5	7	No grade provided	No resolution reached	Proin, 2.2 mg/kg orally BID; continues to have UIC requiring diapers despite proin	No	n/a	n/a
20	NP	Yes	1	9	9, dribbles 1-2×/week when excited	No resolution reached	Proin, 2 mg/kg orally BID; UIC substantially improved after beginning treatment with proin	No	n/a	n/a
21	NP	Yes	5	10	10	21-28 d	No	No	n/a	n/a

Abbreviations: BID, twice daily; NP, not performed; n/a, not applicable; NSF, no significant findings; PO, postoperative; UA, urinalysis; UIC, urinary incontinence.
[a]Severity score: 1 = dog was minimally continent or extremely incontinent (leaking urine all the time); 5 = dog was moderately continent (leaking urine only when lying down or when the urinary bladder was full but able to hold some urine between urinations); 10 = dog was perfectly continent with no urine leakage.

3.5 | Complications

One dog experienced a major intraoperative complication, one dog experienced a major postoperative complication, and six dogs had minor complications. The overall complication frequency was eight of 21. One dog had a major complication and minor complications.

Dog 20 underwent a vulvovaginectomy and had a major intraoperative complication (rectal perforation) and major postoperative complications. The rectal perforation was primarily repaired during the initial procedure but subsequently dehisced and required revision surgeries at 6 and 12 days postoperatively. This dog also developed infection and dehiscence of the perineal urethrostomy site. The perineal urethrostomy site was revised 2 days postoperatively then later failed due to devitalization of the distal urethra. A prepubic urethrostomy was performed 5 days postoperatively.

Dog 14 underwent a complete vaginectomy and had a major postoperative complication. A cystostomy tube was placed for urinary diversion 14 days postoperatively after sequential placement, and trial removal of indwelling urinary catheters was attempted without a successful demonstration of the ability to urinate independently. The tube was removed 133 days after placement, approximately 50 days after normal urination was noted in the record, and no further complications were noted.

Minor complications included UIC (n = 6), urine scald (n = 2), and intermittent mild dyschezia (n = 2). Only one dog (dog 20) experienced surgical site infection. Dogs 2 and 19 exhibited UIC as a sole complication. Among the six dogs that developed UIC, three had vulvovaginectomies performed, one had a complete vaginectomy performed, and two had subtotal vaginectomies performed. Among these six dogs, three resolved spontaneously within 60 days of surgery (Table 3), resulting in three of 21 dogs with permanent UIC; vulvovaginectomies were performed in two dogs, and subtotal vaginectomy was performed in one dog. One of the dogs with permanent UIC after vulvovaginectomy (dog 20) had undergone revision to a prepubic urethrostomy. Dog 1 exhibited UIC that resolved within 48 hours of surgery and was completely urinary continent at the time of discharge from the hospital; this dog had a subtotal vaginectomy performed. Within the 10 to 20-day postoperative period, the median UIC score was 10, with a range of 1 to 10 (6 dogs). At 60 days postoperatively, the median score remained at 10 (range, 7-10; four dogs; Table 2). Among the six dogs that exhibited UIC, three began treatment with medical therapy; dogs 19 and 20 received phenylpropanolamine, and dog 2 received diethylstilbestrol. Among these three dogs, dogs 2 and 20 improved, but the response to therapy was unknown in dog 19 (Table 2). Among the two dogs that presented

TABLE 3 Summary of major and minor complications in dogs

Dog	Surgical procedure performed	Major complication	Minor complication
1	Subtotal vaginectomy	None	UIC grade unknown, resolved in 2 d; mild straining to urinate and defecate at outset of elimination
2	Subtotal vaginectomy	None	UIC grade unknown
7	Subtotal vaginectomy	None	Urinary tract infection; occasional straining to defecate
14	Complete vaginectomy	Cystostomy tube placement	Urinary tract infection
18	Vulvovaginectomy	None	Urinary tract infection
19	Vulvovaginectomy	None	UIC grade 5
20	Vulvovaginectomy	Rectal perforation, surgical site infection, urethral necrosis and dehiscence; revision to prepubic urethrostomy	UIC grade 9; urinary tract infection; urine scalding
21	Vulvovaginectomy	None	UIC grade 5 initially, resolved by 21-28 d PO; urine scalding; hemorrhagic gastroenteritis

Abbreviations: PO, postoperatively; UIC, urinary incontinence.

preoperatively with UIC, dog 2 had minor urine dribbling while in hospital but none after discharge, and dog 6 exhibited no postoperative UIC. Eighteen dogs ultimately achieved and maintained urinary continence long term. Two dogs developed urine scalding, with severity not noted in dog 20, and resolution of urine scald noted with the resolution of incontinence in dog 21. Four dogs developed UTI postoperatively (Table 3).

3.6 | Clinical outcome

The median time to follow-up was 520 days (71-1955). Ten dogs were alive at the time of case accrual; all 10 had benign lesions. The median OST for dogs with malignant tumors was 626 days (95% CI, 71-1245 days), with a median OST of 727 days for dogs with sarcomas (n = 5) and an OST of 71 days for the dog with the UC. The median OST for dogs with benign tumors was not reached. Two dogs (dogs 4 and 13) experienced disease recurrence. Dog 4 had an incompletely excised grade 3 vaginal sarcoma of undetermined subtype (owners declined IHC) and a completely excised grade II/high-grade perivulvar MCT. Metronomic cyclophosphamide and meloxicam were administered. Local recurrence of the vaginal tumor was noted 308 days postoperatively with no recurrence of the MCT noted, and the dog was euthanized 583 days postoperatively because of the local recurrence, although presenting complaint at either visit was not noted in the record. Dog 13 had a completely excised vaginal UC; the pathologist did not provide quantitative surgical margins. This dog received three doses of mitoxantrone chemotherapy. Sixty-nine days postoperatively, local recurrence was detected when the dog was presented for stranguria. Two days later, the dog was euthanized. Dog 12 developed a mass that was determined according to biopsy results to be a soft tissue sarcoma in the same location as a previously excised leiomyoma but was asymptomatic for the new lesion; the owner elected not to pursue further diagnostics or treatment, and the dog was euthanized for unrelated reasons. None of the concurrent masses noted at the time of surgery in any dogs resulted in morbidity or mortality. The remaining dogs died or were euthanized because of reasons unrelated to the lesions for which they had received surgery.

4 | DISCUSSION

Smooth muscle tumors were the most common tumor type for which subtotal vaginectomy, complete vaginectomy, and vulvovaginectomy were performed in this study. The procedures were well tolerated and resulted in low rates of major complications and permanent UIC. Because of the rarity of dogs that had these surgical procedures and also had long-term follow-up, multi-institutional collaboration to accrue cases was required. Our animal population demographics were in line with those in previous studies in that older dogs predominated, most of the dogs were hormonally intact, and benign tumors predominated in the hormonally intact dogs.[1-3,5-7,10,11] The proportion of intact females in our study population (13/21) was lower than that noted in previous publications that reported on 90 bitches[2] and 69 bitches in a cohort of 99 dogs[1] but was similar to more recent, smaller case series.[7,10] Frequency of benign smooth muscle tumors was also higher in previous

publications at 77%[2] and 83%[1]; however, one report grouped fibroleiomyomas, fibromas, and leiomyomas together,[2] making direct comparisons to specific tumor frequencies difficult. The types and distributions of tumors in the present study were consistent with previous reports, with most being of smooth muscle origin and benign.[1-3,5-7,10,11] These data were not surprising because of the association of estrogen with the development of benign vaginal tumors.[2] There may be both temporal differences and regional variations in prevalence of intact vs spayed females that cannot be accounted for, which could have contributed to differences in study populations.

Only one dog in the current study had a UC. This single case of UC may have resulted from several factors, including the diffuse nature and trigonal location of many UC;[12] such dogs are not often surgical candidates, and medical management is the mainstay of therapy.[12] Furthermore, UC can often be diagnosed before surgical intervention because diagnostics such as cytology or biopsy via cystoscopy, urinalysis, and urine *BRAF* mutation tests can all be used,[12] helping to avoid surgery in cases in which medical management is desired. The overall frequency of presentation of UC cases at contributing institutions during the study period is unknown.

While there can be overlap between procedures concerning the degree of dissection and reconstruction required, vaginectomy and vulvovaginectomy are usually described as specific and discrete procedures and were treated as such for the purposes of the study. For example, two dogs in this study underwent total vaginectomy with concurrent urethral reimplantation, leaving the vulva intact. This was classified as a complete vaginectomy and neourethrostomy for this study because the urethra was not directly anastomosed to the skin; the degree of manipulation and repositioning of the distal urethra could be expected to be similar to a vulvovaginectomy. In other studies and case series, dogs in which neo urethrostomies or urethroplasties were performed infrequently had UIC.[6,7,10] While our data are supportive of a low rate of UIC for any of the above procedures, the presence of variables such as the extent of disease, the location of disease, surgical technique, and variation in individual dog anatomy limits the ability to make strong recommendations for specific factors that may directly contribute to postoperative UIC.

While the anatomy of the pelvic plexus and innervation to the region is undoubtedly important, some disruption can be sustained without clinical effects.[13] Bennett et al[13] suggested that the dissection of this region contributes to UIC after prostatectomy in male dogs with prostatic carcinoma while noting that prostatectomy in nondiseased prostates yields significantly lower rates of UIC. Dissection in the region of the bladder and subsequent loosening of pelvic attachments could also theoretically contribute to a more intrapelvic bladder position because the caudal tether of the urethroplasty remains, yet cranial attachments are laxer and, therefore, could contribute to subsequent UIC.[7,10] Furthermore, some degree of UIC could theoretically arise due to the loss of normal tract length and urethral resistance for procedures in which the caudal urinary tract is ultimately altered, such as in urethral reimplantation or perineal urethrostomy. Three of the six dogs that developed UIC, including two of the three dogs that had permanent UIC, had undergone vulvovaginectomies; one of these two dogs then underwent revision to a prepubic urethrostomy. It is possible that, in these dogs, the more extensive dissection and manipulation of this region during the vulvovaginectomy contributed to UIC and that loss of urethral length in the case of prepubic urethrostomy may also have contributed.

An additional factor that can influence the degree of UIC is a dog's hormonal status. Among the three dogs that underwent medical treatment for postoperative UIC, all were intact at the time of surgery. Among these three dogs, two experienced improvements in their UIC score with medical therapy, with one treated with diethylstilbesterol and one treated with phenylpropanolamine; response to therapy was unknown in the third. Given the response associated with the diethylstilbesterol treatment in dog 2, it could be postulated that the loss of urinary continence was at least partially due to reduced estrogen; however, this is unlikely because of how rapidly UIC developed postoperatively in these dogs, especially as estrogen-responsive UIC can take over 3 years to develop after adult ovariohysterectomy.[14] Meanwhile, treatment via α-adrenergic agonist therapy may have resulted in improvement in dog 20 in concert with or independent of the loss of estrogen influence; this dog had undergone several surgeries and ultimate conversion to prepubic urethrostomy, so the opportunity for disruption of sympathetic innervation was greater in this dog. The potential delay in clinical onset may have prevented the detection of UIC in other dogs because dogs 7, 16, and 17 were lost to follow-up after 104, 350, and 106 days, respectively, postoperatively. Furthermore, three dogs that were still alive at the time of case accrual had less than 1 year of follow-up. The relationship between hormonal status and UIC remains tenuously defined at best, and the retrospective nature of the present report prevents its assessment via evaluation of response to estrogen supplementation.

From a clinical standpoint, information regarding the incidence of postoperative UIC is important because some owners may not be willing to manage a urinary incontinent dog. Furthermore, some owners may perceive UIC as an impedance to an appropriate quality of

life. The low rate of permanent UIC exhibited by the dogs in this study underscores that, while this is a possible complication, particularly in the short term, it is a rare complication. Furthermore, of the two dogs that presented with UIC as an initial presenting complaint, neither dog went on to have postoperative UIC beyond 3 days postoperatively, which may provide evidence that the presence of preoperative UIC may not be predictive of postoperative urinary continence status.

The prolonged survival of dogs in this study, especially those with benign tumors, provides evidence to support our hypothesis. All dogs in the current study with a benign vaginal disease, regardless of extent, had a good clinical outcome with no recurrence of the disease, which is consistent with other reports.[1-3,5,7,10,11] Specifically, dog 2 received diethylstilbestrol treatment for postoperative UIC after subtotal vaginectomy for a leiomyoma and ovarian remnant removal, and recurrence was not noted despite continued iatrogenic estrogen influence; this is in line with findings in past studies in which not all dogs that were left intact exhibited disease recurrence.[1,11] All other dogs that had benign tumors and were spayed at the time of surgery exhibited no disease recurrence, in line with previous reports.[1,4] Disease recurrence was also infrequently noted in dogs with malignant disease. Dogs with a malignant vaginal disease also had good clinical outcomes except for one dog, and, similar to previous studies, local recurrence occurred in only two dogs.[1,7] The geriatric nature of the population could mean that disease recurrence is underappreciated because of the shorter relative lifespan of these dogs. It is interesting to note that, despite the fact that several dogs had concurrent morbidities noted at the time of surgery, none had morbidity or mortality postoperatively.

This study has several limitations, the most notable of which is related to its retrospective nature. The inability to control for surgeon experience or technique introduces potential for variability in outcomes. Many clients were contacted regarding follow-up; however because all participating institutions were tertiary referral centers, it is possible that minor complications, such as transient UIC, were managed by the referring veterinarian and were not reflected in the records reviewed. Every effort was made to prevent this via follow-up contact with both the referring veterinarian and owners. Similarly, certain details of the postoperative case progression were either not available for review or dependent on owner recollection, the latter of which may not always have been accurate. Despite contributions from multiple centers, the number of dogs in which these procedures were performed was low, precluding stratification by procedure type and histopathologic diagnosis in the analysis. While multi-institutional studies have these limitations, they also provide a realistic view of expected outcomes because results from a single institution or single surgeon may be biased by case selection and experience.

In conclusion, vaginectomy and vulvovaginectomy resulted in prolonged survival and low rates of major complications and permanent UIC. This study provides evidence to recommend that the risks of this procedure and expectations should be discussed with clients.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest related to this report.

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