Feasibility and Safety of Canine Orchiectomy Using Scrotal Approach and a Vessel-Sealing Device: A Prospective Observational Study of 200 Cases

Christos Yiapanis

1Cyvets Veterinary Centre, Tassou Papadopoulou Avenue

Ciprian Ober (✉ ciprian.ober@usamvcluj.ro)

University of Agricultural Sciences and Veterinary Medicine

Maria Potamopoulou

Grove Veterinary Hospital, Grove House

Theodoros Vasilakis

1Cyvets Veterinary Centre, Tassou Papadopoulou Avenue

Joshua Milgram

The Hebrew University of Jerusalem

Research Article

Keywords: Canine orchiectomy, scrotal approach, monopolar electrosurgery, automutilation (AM)

Posted Date: September 28th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-818635/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Abstract

Background: Canine orchiectomy involves making an incision in the prescrotal area, exteriorizing both testes via the same incision, ligating the blood vessels and spermatic cord, removing the testes, and suturing the incision. A briefer durations of anesthesia and surgery and decrease of postoperative morbidity could be obtain using a vessel sealing device. The aim of this study was to determine the feasibility and safety of orchiectomy in dogs by a scrotal approach with the use of a vessel-sealing device. Scrotal orchiectomy was performed with the use of monopolar electrosurgery device in pure cutting mode and a vessel-sealing device. Data were collected prospectively for the following categorical variables: breed, age, body weight, lifestyle, surgical time, indications for surgery and complications.

Results: No complications were reported in 187 of 200 (93.5%). The complications documented were automutilation (AM), incisional complications (IC) and scrotal complications (SC). AM complications (11/200 [5.5%]) and SC complications (2/200 [1%]) were treated without additional surgery and resolved by day 10 after the surgery. Procedure duration (2,1 minutes $\pm$ 0.4 minutes) was briefer than traditional castration duration reported in literature (3.5 $\pm$ 0.4 minutes).

Conclusions: Results suggested that canine orchiectomy by scrotal approach with the use of a vessel-sealing device was feasible and safe. Furthermore, it was associated with a low complication rate and had the benefit of reduced surgical time and postoperative morbidity. This technique is promising for widespread application in veterinary surgery to help with haemostasis in canine orchiectomy.

Background

Canine orchiectomy is one of the most commonly performed surgical procedures in first opinion small animal practice worldwide [1–4]. The most common indication for orchiectomy is surgical sterilization (neutering). Other indications are the reduction of androgen-related disorders (anxiety and aggressiveness), the tendency to roam, undesirable urination, prostatic disease, perianal adenomas, perineal hernias, the prevention of hereditary diseases, testicular abnormalities, scrotal urethrostomy, inguinal-scrotal herniorrhaphy and endocrine abnormalities [5].

There is a wide variety in the techniques used to perform orchiectomy in dogs. The technique is influenced by geographic areas, the age and the size of the patient, finances, and the purpose of the procedure [4]. Common approaches used in adult dogs are via a prescrotal incision, scrotal ablation, and a perineal approach when performing perineal surgery. A scrotal approach has been proposed in prepuberal dogs [6, 7], and for castrating adult dogs of any age [8–10]. This approach may offer advantages that include improved cosmesis, decreases in anesthetic and surgical times, smaller incision length and less surgical trauma, decreased postoperative discomfort, less self-trauma and decreased likelihood of formation of scrotal hematoma [8–10].

Severe complications of orchiectomy are rare, but may include scrotal swelling and bruising, hemorrhage, scrotal hematoma, abscess, granuloma, incisional problems (swelling, seroma formation, cellulitis, infection, automutilation, dehiscence), urinary incontinence, endocrine alopecia, behavioral changes and eunuchoid

syndrome [11]. Most complications associated with orchiectomy can be prevented by using good surgical technique, including gentle tissue handling, good hemostasis, and aseptic technique [12].

Hemorrhage from poorly ligated vascular pedicles can result in scrotal hemorrhage or intraabdominal bleeding due to the retraction of the bleeding vascular pedicle through the inguinal canal [7]. Traditionally haemostasis is achieved with the use of ligatures but their reported disadvantages are occasional ligature slippage, introduction of foreign matter, difficult management, high cost, size limitation and application time [13]. For these reasons the use of electrosurgical devices with enhanced safety characteristics have gained popularity in small animal surgery [14]. Vessel sealing devices (VSD) achieve haemostasis by the fusion of elastin and collagen in the vessel walls and surrounding connective tissue using moderate compression at a temperature less than 100°C (212°F). The low energy used in these devices results in less collateral thermal spread and tissue damage when compared to the traditional electrocoagulation devices [15, 16]. Ligasure is a feedback- controlled bipolar vessel sealing device that is now well established in human and equine surgery and has been shown to be effective in sealing vessels up to 7 mm in diameter [17].

The aim of this study was to evaluate the feasibility and safety of Ligasure vessel-sealing device for closed orchiectomy via scrotal approach. We hypothesized that the technique will be fast and the complication rates would be low.

Results

The descriptive statistics are reported at Table 1. The majority of the dogs enrolled were privately owned (79.0%, 158/200) and the most common indication for this operation was neutering (92.0% 184/200). 84 dogs (42.0%) weighted less than 10kg while the remaining 116 (58%) weighted more than 10kg at the day of the surgery. The mean duration of canine orchiectomy by scrotal approach using a vessel-sealing device was 2.1 with a SD (standard deviation) of 0.5. Complications were noted in 13 dogs (6.5%) and all of them were reported during the first 24 hours post-operatively (Table 2).

Table 1
Characteristics of the study dogs underwent
orchietomy by scrotal approach using a
vessel-sealing device

Characteristic	Dogs (%) (N = 200)
Age in years	
Mean	3.7
Standard deviation	2.8
Breed	
Pedigree	51 (25.5)
Crossbreed	149 (74.5)
Weight	
<10kg	84 (42.0)
11-20kg	68 (34.0)
>20kg	48 (24.0)
Lifestyle	
Private	158 (79.0)
Shelter	42 (21.0)
Indication for surgery	
Neutering	184 (92.0)
Prostatic disease	7 (3.5)
Testicular disease	4 (2.0)
Other	5 (2.5)
Duration of surgery in mins	
Mean	2.1
Standard deviation	0.5
Complication	
None	187 (93.5)
AMIC	11 (5.5)
AMICSC	2 (1.0)

Table 2
Summary of the dogs that developed complications and associated treatment

Case	Breed	Age (Year)	Weight (kg)	Origin: private/shelter	Day after surgery	Complication	Treatment
13	Pomeranian	4	5	Private	1	AM/IC	BC/IP
21	Chihuahua	3	3	Private	1	AM/IC	BC
46	Labrador	3	27	Private	1	AM/IC/SC	BC/IP/ANG/ATB
50	Cross breed	3	5	Private	1	AM/IC	BC/IP
75	Poodle	5	7	Private	1	AM/IC	BC/IP
114	Pointer	2	16	Private	1	AM/IC	BC/IP
118	Poodle	1	6	Private	1	AM/IC/SC	BC/ANG/ATB
136	Cross breed	1	5	Private	1	AM/IC	BC/IP
141	Pomeranian	1	4	Private	1	AM/IC	BC/IP
152	Husky	1	25	Private	1	AM/IC	BC/IP
163	Pincher	2	7	Private	1	AM/IC	BC
183	Hound	1	10	Shelter	1	AM/IC	BC/ANG/ATB
197	Spaniel	10	13	Private	1	Am/IC	BC/ANG/ATB

The results from univariable analysis on continuous and categorical variables are shown in Tables 3 and 4 respectively. The only variable that was significantly associated with complications (including both AMIC and AMICSC) following orchiectomy by scrotal approach using a vessel-sealing device was the weight of the dog. Dogs that were less than 10 kg were 3 times (CI: 0.9–11.3, $P = 0.040$) more likely to develop complications compared to the dogs that weighed more than 10 kg. There was no variable that showed a trend towards significance thus the multivariable logistic regression did not yield any additional findings.

Table 3

Univariable analysis for associations between continues variables and complications in dogs that underwent orchiectomy by scrotal approach using a vessel-sealing device.

Variable	No. of dogs (N = 200)	Complications		OR	95% CI for OR	P-value
		Yes (%)	No (%)			
<i>Breed</i>						
Pedigree	51	5 (9.8)	46 (90.2)	1.9	0.6–6.1	0.267
Crossbreed	149	8 (5.4)	141 (94.6)			
<i>Weight</i>						
< 10kg	84	9 (10.7)	75 (89.3)	3.4	0.9–11.3	0.040
> 10kg	116	4 (3.4)	112 (96.6)			
<i>Lifestyle</i>						
Private	158	11 (7.0)	147 (93.0)	0.6	0.1–3.1	0.607
Shelter	42	2 (4.8)	40 (95.2)			
<i>Indication for surgery</i>						
Neutering	184	12 (6.5)	172 (93.5)	0.9	0.1–7.8	0.966
Non-neutering causes	16	1 (6.3)	15 (93.8)			

Table 4

Univariable analysis for associations between categorical variables and complications in dogs that underwent orchiectomy by scrotal approach using a vessel-sealing device. Significant *P*-values ≤ 0.05 are shown in bold

Variable	Complications (N = 200)	Mean	SD	P-value
Age in year	Yes 13 (6.5)	4.1	4.1	0.516
	No 187 (93.5)	3.6	2.6	
Duration of surgery (minutes)	Yes 13 (6.5)	1.9	0.5	0.239
	No 187 (93.5)	2.1	0.4	

Discussion

We hypothesized that the technique will be fast and the complication rates would be low in the study population. The first hypothesis was supported in that procedure durations was briefer than those reported for traditional prescrotal castration as mentioned by Miller et al (2018) [18] (1,9 minutes $\pm$ 0.5 minutes in cases with complications and 2,1 minutes $\pm$ 0.4 minutes in cases without complications in this study compared with 3.5 $\pm$ 0.4 minutes reported by Miller et al.). Based on this, we concluded that the technique in

this study provides a rapid technique for castration. Shorter duration of castration in male dogs using Ligasure were reported also by Faluvégi et al. 2018 [19], but they used a prescrotal approach.

Another hypothesis for the present study was that the complication rate would be low. This hypothesis was supported in that presented technique resulted in no haemorrhagic complications for any of the 200 surgeries performed, and minor complications observed were self-limiting and only few. Based on these results, we concluded that the Ligasure scrotal technique provides a rapid and safe approach for canine orchiectomy.

Major hemorrhage associated with orchiectomy is uncommon in dogs [20], and most complications involving hemostasis result in scrotal hematomas, likely due to oozing from the vaginal tunic with open orchiectomy [1, 20]. According to Miller's et al. experience [18], large dogs with large gonads will generally have a larger gonadal blood supply than small dogs with small gonads. Interestingly, dogs that were less than 10 kg were 3 times (CI: 0.9–11.3, $P = 0.040$) more likely to develop complications compared to the dogs that weighted more than 10 kg in our study. Anyway, the complications were not due to hemorrhage. No hemostatic complications were seen after Ligasure application in our study. The weight of the dog was the only variable that was significantly associated with complications (including both AMIC and AMICSC) following orchiectomy by scrotal approach using a vessel-sealing device in this study. We consider the behaviour and temperament of the small dogs to be mostly responsible for incisional complications.

All complications were identified at 24 hours post-surgery assessment and resolved without additional surgery. All incisional complications were managed by telephone communication with the owners. None of the owners with incisional complications felt that their dog required additional analgesia. The cases that developed incisional and scrotal complications (dog 46 and 118) were admitted for examination and additional analgesia with NSAIDs and antibiotics were administered. None of the cases required hospitalization or additional surgery. Both complications were encountered in client owned animals. In case 118, the owners were unable to apply the buster collar as soon as automutilation was noticed due to aggression of the dog. In case 46 that both incisional and scrotal complications were also observed, the application of the collar was delayed because the dog was left unattended for several hours. Based on this, we can assume that automutilation is an important factor in the appearance and progression of complications. In the authors' experience, shelter animals had less complications, assuming that the distractions in the environment prevented automutilation or complications passed unnoticed.

In the uncomplicated cases contraction of the scrotum and elimination of the incisional gap was observed by day 3. In all cases that the complications were observed, sufficient regression of the scrotum with no incisional gap was observed by day 10. In the cases that both incisional and scrotal complications were observed (46, 118), some skin discoloration remained in the scrotal region by day 10. Nevertheless, the majority of the animals in the study did not require buster collar, and strict exercise restriction was limited to 24 hours post discharge. Interestingly, the limited postoperative restrictions and the avoidance of the buster collar were factors that were strongly appreciated by the owners when they were questioned regarding owners satisfaction. Assessment at 10 days after surgery is routinely performed by several practices but the value of assessment at this time point is questionable due to the fact that the majority of the complications arise the first days after the procedure [5]. Due to the uncomplicated healing and the rapid elimination of the incisional gap, most owners felt that further assessment was not necessary.

Activation of the vessel sealing system uses electrosurgical radiofrequency energy that causes the collagen and elastin in the blood vessel walls to reorganize within the tissue thereby forming a permanent seal [21]. Monopolar electrosurgery was used to incise the scrotal skin, and to control minor bleeding from septal vessels. Even though skin incisions made with monopolar electrosurgery were associated with decreased healing compared to scalpel made incisions [21], sufficient regression of the scrotum and no incisional gap was evident by day 10 in all cases. Clearly benefits in hemostasis improvements, and overall anaesthesia and surgery time reduction were demonstrated in many studies [22–27]. Even though there are reasonable concerns regarding the high cost of using VSD in routine procedures, appropriate re-sterilisation of the hand piece allows a significant reduction in the costs by increasing the number of procedures without decreasing safety characteristics [13, 28].

Several limitations of the study should be considered when interpreting the results. Some incisional complications could have developed beyond the 24-hour postoperative. Anyway, the owners were instructed to report any complication with the surgery. Similar to our study, in a previous report [5], most complications following canine orchiectomy were discovered at the 24-hour recheck examination and no complications were found at the next recheck examination, performed 10 days after surgery. The authors of the study also advocated for rechecking of patients in the immediate postoperative period and questioned the value of rechecking the patients 10 days after surgery.

We found only one study of postoperative complications after Ligasure orchiectomy in the peer-reviewed veterinary literature, thus, direct comparisons with the findings of the present study is limited [19]. Moreover, the authors of the study used prescrotal approach, thereby precluding any meaningful comparison with our data.

Another limitation of the study include the use of semiobjective methods for documenting each complication and the fact that the assessment of the majority of the cases was based on owners perception. For these reasons, long-term results should be evaluated in a larger randomized prospective studies.

Conclusion

The low complication rate and time advantage associated with use of the Ligasure technique for orchiectomy of dogs suggested important advantages, including shorter durations of anesthesia and surgery than with the traditional prescrotal technique. We expect that as the Ligasure technique is more widely used, morbidity and mortality rates associated with canine orchiectomy will improve as will savings in resources, such as time and suture materials. The results of the present study provide important data for the veterinarians who perform such surgeries.

Methods

A prospective observational study for canine orchiectomy by scrotal approach using a vessel-sealing device was performed at the CYVETS Veterinary Centre from December 2015 to December 2018. Two hundred healthy intact male dogs were recruited in this study (Table 5). The age of the study population ranged from 0.8 to 12 years [mean 3.7 years, standard deviation (SD) 2.8] and 149 (74.5%) were crossbreed. Dogs less

than seven years old were determined to be healthy based on medical history and physical examination performed on the day of surgery, whilst dogs more than seven years old routine biochemistry and haematology were performed prior to anesthesia to determine health status. The intact male dogs enrolled in the study following a signed consent form by the owners or guardians were presented either from local animal welfare organizations or were client-owned dogs. No dog underwent any procedure specifically for this study and all procedures were performed in accordance of the Cypriot legislation [The Dogs LAW, N. 184 (I)/2002].

Table 5
Characteristics of the population

	BREED	AGE YEARS	SIZE KG	PRIVATE	SHELTERS
1	HOUND	5	10		X
2	HOUND	4	15	X	
3	CROSS BREED	4	7	X	
4	PINCHER CROSS	4	5	X	
5	BISCON FRISE	11	5	X	
6	ENGLISH SPRINGER SPANIEL	4	13	X	
7	TERRIER	3	11	X	
8	CROSS BREED	4	5	X	
9	POINTER	4	15	X	
10	ROTTWEILER	3	27	X	
11	AMER.STAFFOR.TERRIER	4	20		X
12	POODLE	3	5		X
13	POMERANIAN	4	5	X	
14	HOUND	4	10		X
15	POODLE	7	8		X
16	HUSKY	4	32	X	
17	POODLE	7	4		X
18	LABRADOR	6	30	X	
19	MINI DOBERMAN	4	8	X	
20	CROSS BREED	4	7	X	
21	CHIHUAHUA	3	3	X	
22	LABRADOR	3	25	X	
23	CROSS BREED	3	5	X	
24	BICHON FRISE	3	8	X	
25	BICHON FRISE	3	6	X	
26	BICHON FRISE	3	8	X	
27	CROSS BREED	4	12		X
28	POODLE	4	6		X

	BREED	AGE YEARS	SIZE KG	PRIVATE	SHELTERS
29	POODLE	3	5		X
30	Yorkshire TERRIER	3	5	X	
31	CROSS BREED	3	9	X	
32	POMERANIAN	3	3	X	
33	BELGIAN MALINOIS	4	17	X	
34	CAIRN TERRIER	3	12	X	
35	MALTEZE	3	5	X	
36	CANE CORSO	3	40	X	
37	Yorkshire TERRIER	3	7		X
38	DOBERMAN	3	31	X	
39	CROSS BREED	6	12	X	
40	CROSS BREED	3	10	X	
41	CROSS BREED	3	10	X	
42	HOUND	4	18	X	
43	LABRADOR	11	43	X	
44	HOUND	11	34	X	
45	CROSS BREED	4	8	X	
46	LABRADOR	3	27		X
47	BICHON FRISE	3	7	X	
48	HUSKY	4	21	X	
49	VIZLA CROSS	3	10	X	
50	CROSS BREED	3	5	X	
51	CROSS BREED	8	10		X
52	GERMAN SHEPERD CROSS	3	10	X	
53	LABRADOR	5	17	X	
54	BOXER	3	27	X	
55	HOUND	3	15	X	
56	POMERANIAN	3	5	X	
57	BEAGLE	7	19	X	

	BREED	AGE YEARS	SIZE KG	PRIVATE	SHELTERS
58	JACK RUSSELL	5	5	X	
59	LABRADOR	3	19	X	
60	POODLE	12	11	X	
61	SCHNAUZER	3	21	X	
62	HUSKY	3	35	X	
63	CROSS BREED	3	15	X	
64	ROTTWEILER	2	30	X	
65	SPRINGER SPANIEL	3	15	X	
66	TERRIER	2	11		X
67	HUSKY	4	23	X	
68	GERMAN POINTER	3	29	X	
69	BEAGLE	3	15	X	
70	CROSS BREED	6	5	X	
71	CROSS BREED	4	5	X	
72	DACHSHUND	15	10	X	
73	BEAGLE	3	15	X	
74	CROSS BREED	2	10	X	
75	POODLE	5	7	X	
76	BEAGLE	6	17	X	
77	POINTER	3	18	X	
78	CROSS BREED	4	18	X	
79	HOUND	5	15		X
80	YORKSHIRE-TERRIER	10	4	X	
81	CROSS BREED	6	15	X	
82	CROSS BREED	4	12	X	
83	YORKSHIRE-TERRIER	2	5	X	
84	LABRADOR CROSS	6	50	X	
85	CROSS BREED	2	9	X	
86	CROSS BREED	2	5	X	

	BREED	AGE YEARS	SIZE KG	PRIVATE	SHELTERS
87	CROSS BREED	2	5	X	
88	HOUND	2	15	X	
89	CROSS BREED	2	26	X	
90	FRENCH BULLDOG	2	10	X	
91	BEAGLE	4	17	X	
92	CROSS BREED	3	12	X	
93	CROSS BREED	4	15	X	
94	CROSS BREED	3	6	X	
95	CROSS BREED	3	6	X	
96	POODLE	12	27	X	
97	AMERICAN PITBULL	7	24	X	
98	CROSS BREED	2	25	X	
99	CHIHUAHUA	2	3	X	
100	CROSS BREED	6	11	X	
101	PEKINGESE	2	7	X	
102	LABRADOR CROSS	2	17	X	
103	GERMAN SHEPHERD	3	32		X
104	CROSS BREED	2	6	X	
105	SHAR PEI	2	21	X	
106	CROSS BREED	2	17	X	
107	POMERANIAN	4	4	X	
108	CROSS BREED	3	6	X	
109	POINTER CROSS	2	16		X
110	CROSS BREED	2	27	X	
111	BICHON FRISE	14	9	X	
112	HOUNT	10	23	X	
113	POODLE CROSS	17	8	X	
114	POINTER	2	16	X	
115	JAPANESE CHIN	2	7	X	

	BREED	AGE YEARS	SIZE KG	PRIVATE	SHELTERS
116	LABRADOR CROSS	3	15	X	
117	PUG	2	8		X
118	POODLE CROSS	1	6	X	
119	CROSS BREED	2	5	X	
120	POODLE	2	9	X	
121	LABRADOR CROSS	9	33		X
122	CROSS BREED	2	7		X
123	CROSS BREED	11	10		
124	GERMAN SHEPHERD	2	29	X	
125	GERMAN SPITZ	3	10	X	
126	HOUND	2	10	X	
127	TERRIER	1	8	X	
128	TERRIER	3	11	X	
129	SAMOYED	8	36	X	
130	PIT BULL	1	22	X	
131	TERRIER	2	7	X	
132	GERMAN SHEPERD CROSS	7	35	X	
133	ROTTWEILER	1	35	X	
134	CROSS BREED	1	12	X	
135	POODLE CROSS	6	13	X	
136	CROSS BREED	1	5	X	
137	CROSS BREED	2	7	X	
138	GERMAN SHEPHERD	6	42	X	
139	CROSS BREED	1	19	X	
140	SALUKI	2	22	X	
141	GERMAN SPITZ	1	4	X	
142	AMER.STAFFOR.TERRIER	1	22	X	
143	POODLE	2	8	X	
144	ROTTWEILER	1	14	X	

	BREED	AGE YEARS	SIZE KG	PRIVATE	SHELTERS
145	CROSS BREED	11	12	X	X
146	GERMAN SHEPERD CROSS	2	21		X
147	HOUND	2	12		
148	ROTTWEILER	4	42	X	
149	PUG	2	9	X	
150	POINTER	2	20	X	
151	CROSS BREED	0.8	6	X	
152	HUSKY	1	25		X
153	CROSS BREED	1	9	X	
154	HOUND	2	15	X	
155	CROSS BREED	4	7	X	
156	HOUND	1	15	X	
157	GERMAN SHEPERD CROSS	2	21		X
158	CROSS BREED	0.8	19	X	
159	WEIMARANER	1	17		X
160	VISZLA	1	18		X
161	HOUND	2	13		X
162	POINTER	3	20	X	
163	PINCHER	2	7	X	
164	POINTER	2	18	X	
165	CHIHUAHUA	3	4	X	
166	HOUND	2	18		X
167	HOUND	3	25		X
168	CROSS BREED	2	15		X
169	POINTER	1	30	X	
170	STAFFORDSHIRE TERRIER	3	22	X	
171	HOUND	7	20		X
172	HOUND	1	16		X
173	GERMAN SHEPERD	1	22	X	

	BREED	AGE YEARS	SIZE KG	PRIVATE	SHELTERS
174	FRENCH BULLDOG	8	11	X	
175	COCKER SPANIEL	2	15	X	
176	DOBERMAN	3	38	X	
177	ROTTWEILER	3	43	X	
178	LABRADOR	1	16	X	
179	SHARPEI	2	18	X	
180	GERMAN SHEPHERD	6	37	X	
181	CROSS BREED	5	16	X	
182	PEKINGESE	3	7	X	
183	HOUND	1	10		X
184	CROSS BREED	6	6	X	
185	LABRADOR	2	20		X
186	STAFFORDSHIRE TERRIER	6	28	X	
187	POODLE	2	9		X
188	LABRADOR	2	22		X
189	POODLE	2	11		X
190	LABRADOR	1	18		X
191	HOUND	1	15		X
192	PINCHER	2	10	X	
193	PINCHER	1	8	X	
194	CROSS BREED	2	7		X
195	CROSS BREED	2	9		X
196	LABRADOR	4	27	X	
197	COCKER SPANIEL	10	13	X	
198	POODLE	1	8	X	
199	HOUND	1	12	X	
200	POODLE	2	10		X

The surgical procedures were performed by a single veterinary surgeon (CY) in order to avoid interobserver variability. Data were recorded and included breed, bodyweight, age, total surgical time, lifestyle

(private/shelter) and the encountered complications up to 10 days post surgery.

All protocols were standardized prior to commencing the study. These included: preparation for aseptic surgery, surgical procedure, recovery protocol, postoperative instructions and client communication. Orchiectomy time was measured from immediately prior the skin incision to apposition of the incision site and dogs were categorized based on body weight into small (< 10kg), medium (10 to 20 kg) and large breed (> 20 kg). Associated surgical complications were documented including automutilation, incisional complications (hemorrhage, bruising, swelling, erythema) and scrotal complications (swelling, bruising, hematoma). The treatments/measures employed to address the encountered complications were buster collar application (BC) and ice packs (IP) in all complications and additional analgesia with non-steroidal anti-inflammatory medication and antibiotics in the cases with combination of incisional and scrotal complications.

Perioperative management

All dogs were anaesthetised by use of standard clinical protocols. Young healthy dogs were premedicated with 0.02 mg/kg medetomidine (Domitor Pfizer) intravenously (iv) and 0.02 mg/kg butorphanol (Dolorex Merck) iv. Induction to anesthesia was achieved with 1 to 3 mg/kg propofol (Propofol 1%, Fresenius pharma) slowly iv to effect and maintained with 2% inspired isoflurane (isoflo 100%, Abbott pharma) in oxygen with the use of a Bain circuit. In patients over 10 years old, medetomidine was replaced by 0.2 mg/kg midazolam (Dormicum Roche) iv. Anaesthesia was monitored by clinical assessment and a multi parameter anaesthesia monitor. All dogs received 0.2 mg/kg meloxicam (Metacam Boehringer) iv before anesthesia. Additional analgesia with butorphanol was administered after surgery in patients with evidence of pain (WSAVA, 2014). A small square area around the incision site was clipped with slow-powered clippers with 0.5mm blade. Care was taken not to traumatize the sensitive scrotal skin during clipping. The skin was prepared with surgical scrub (Dermanios Scrub CG, Anios lab) followed by 2% Chlorhexidine Digluconate solution (Chlorhexidine Concentrate 5 vol. % CD, Krusan). The patients were positioned in dorsal recumbency and draped with a round fenestrated self-adhesive drape.

Surgical procedures

The left testicle was grasped between the thumb and index of the surgeon and directed caudoventrally while pulling the scrotal skin taut over the testicle. The scrotal skin cranial and ventral to the median raphe at the apex of the scrotum, was incised with a monopolar electrosurgery device (Eschmann TD830), in pure cutting mode at 100-150W output (small and medium-large patients respectively), approximately one-third of the length of the long axis of the testicle (0.5 – 2 cm) (Fig. 1A). The incision was continued through the spermatic fascia until the parietal tunic was seen. The testicle within the parietal layer of the vaginal process was exteriorised, and the spermatic cord was exposed by reflecting all visible connective tissue from the parietal tunic with a gauze sponge. A 10-mm instrument (LigaSure Atlas Sealer/Divider—LS10) connected to a bipolar, feedback-controlled vessel sealing device (LigaSure Generator-Valleylab, Boulder, Colorado, USA) with a power setting of three bars was applied to the spermatic cord and the instrument was activated to achieve hemostasis (Fig. 1B). The sealing and transection time was less than 5 seconds per cord, appreciably faster than suture ligation. After hemostasis was completed, the spermatic cord was transected with scissors and

the stump was returned to the scrotum (Fig. 1C,D). The second testicle was removed using the identical technique. After completing the procedure the skin was opposed by gentle approximation of the incision edges (Fig. 1E).

Postoperative care

All dogs were hospitalised for 6–8 hours after surgery. During this period they were closely monitored for signs of pain, haemorrhage and swelling of the surgical site. The assessment of the amount of pain was carried out hourly and was based on the observation of the demeanor and posture of the animal in the kennel and during the interaction with the dog while examining the wound for signs of surgery associated complications. Following discharge from the clinic, all owners were instructed to rest their dogs for 1 day. Short lead walks four to five times a day for toileting were permitted. Progressive return to exercise over one week was advised, if healing was uncomplicated. Owners were instructed not to dress or treat the wound. A buster collar was provided to the owners but it was not applied to the animals. Owners were advised to monitor the surgical wound twice daily and apply the buster collar and contact the members of the staff if self-trauma, discomfort or swelling were evident at the surgical site.

Follow up phone calls to the owners were conducted on day 1 after discharge and on day 10. An additional phone call was conducted on day 5 in the cases that any complication was reported. During the communication, a standard questionnaire format was employed and the owner's comments were documented.

Statistical analysis

Data were recorded into Microsoft Office Excel 2016 and then imported into SPSS (version 22.0; SPSS Inc., Chicago IL, USA) for statistical analysis. Descriptive statistics were performed for the continuous variables of age and duration of surgery, as well as for the following categorical variables: breed, body weight (small, medium and large), lifestyle (private or shelter), indications for surgery (neutering, prostatic disease, testicular disease and other) and complications (none, AMIC, AMICSC). Independent t-test was used to evaluate for associations between continuous variables and complications. To investigate any association for complications and categorical variables a univariable analysis conducted using Chi-square test. A multivariable logistic regression was performed to test for possible risk factors associated with complications. The independent variables that yielded P-values of < 0.2 in a univariable analysis were then tested in a multivariable logistic regression analysis. A P-value ≤ 0.05 was considered statistically significant. The P-values with odds ratio (OR) and 95% confidence interval (CI) were reported.

Abbreviations

AM: automutilation; ANG: Analgesia; ATB: Antibiotics; BC: Buster collar; CI: confidence interval; IC: incisional complications; IP: Ice Packs; OR: odds ratio; SC: scrotal complications; SD : standard deviation

Declarations

Ethics approval and consent to participate

All procedures were approved by the Ministry of Agriculture, Development and Environment, Veterinary Services, (protocol number 1/2021) and performed according to the Cypriot legislation [The Dogs LAW, N. 184 (I)/2002]. All owners gave informed written consent for their dogs inclusion in the study. The study was carried out in compliance with the ARRIVE guidelines.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analysed during this study are included in this published article.

Competing interests

The authors declare that they have no competing interests.

Funding

Not applicable.

Authors' contributions

CY, CO and JM made substantial contributions to the conception of the study design, acquisition, analysis and interpretation of data; MP and TV contributed to the data analysis and critically revised important intellectual content. All authors read and approved the final manuscript.

Acknowledgements

Not applicable.

References

1. Pollari FL, Bonnett BN, Bamsey SC, Meek AH, Allen DG. Postoperative complications of elective surgeries in dogs and cats determined by examining electronic and paper medical records. *JAVMA* 1996; 208:1882-6.
2. Howe LM. Surgical methods of contraception and sterilization. *Theriogenol.* 2006;66:500-09.
3. Reichler IM. Gonadectomy in cats and dogs: a review of risks and benefits. *Reprod Dom Anim.* 2009;44:29-35.
4. Adin CA. Complications of ovariohysterectomy and orchidectomy in companion animals. *Vet Clin North Am-Small Anim Pract.* 2011; 41:1023-39.
5. Hamilton K, Henderson E, Toscano M, Chanoit G. Comparison of postoperative complications in healthy dogs undergoing open and closed orchidectomy. *JSAP.* 2014;55:521–6.
6. Crane SW. Orchiectomy of descended and retained testes in the dog and cat. In: Bojrab, MJ, editor. *Current Techniques in Small Animal Surgery*, 4th edn. Baltimore:Williams & Wilkins; 1998. p. 517-523.

7. Goethem VB. Orchiectomy. In: Griffon D, Hamaide A, editors. *Complications in Small Animal Surgery*. John Wiley & Sons, Inc, 2016. p. 528-533.
8. Johnston DE, Archibald J. Male genital system. In: Archibald J, editor. *Canine Surgery*. 2nd ed. Santa Barbara, CA: American Veterinary Publications; 1974. p. 703-749.
9. Bushby PA. Surgical techniques for spay/neuter. In: Zawistowski ML, editor. *Shelter Medicine for Veterinarians and Staff*. 2nd ed., Wiley-Blackwell; 2013. p. 625-645.
10. Woodruff K, Bushby PA, Rigdon-Brestle K, Wills R. Scrotal castration versus prescrotal castration in dogs. *Vet Med*. 2015;110:131–5.
11. Boothe HW. Testes and epididymides. In: Slatter DH, editor. *Textbook of Small Animal Surgery*. 3rd edn. W. B. Saunders:Philadelphia; 2003. p. 1521-1531.
12. Hedlund CS. Surgery of the reproductive and genital systems. In: Fossum TW, editor. *Small Animal Surgery*, 3 rd Ed., St.Louis:Mosby, Elsevier, 2007. p. 702-774.
13. Gracia-Calvo LA, Martín-Cuervo M, Jiménez J, Vieítez V, Durán ME, Argüelles D, Ezquerro LJ. Intra and postoperative assessment of re-sterilised Ligasure Atlas for orchidectomies in horses: clinical study. *Vet Rec*. 2012;171:98.
14. Diamantis T, Gialikaris S, Kontos M, Gakiopoulou C, Felekouras E, Papalois A, et al. Comparison of safety and efficacy of ultrasonic and bipolar thermal energy: an experimental study. *Surg Lapar End Percutan Techn*. 2008; 18:384-390.
15. Kennedy JS, Stranahan PL, Taylor KD, Chandler JG. High-burst-strength, feedback-controlled bipolar vessel sealing. *Surg Endosc*. 1998;12:876–8.
16. Landman J, Kerbl K, Rehman J, Andreoni C., Humphrey PA., Collyer W, et al. Evaluation of a vessel sealing system, bipolar electrosurgery, harmonic scalpel, titanium clips, endoscopic gastrointestinal anastomosis vascular staples and sutures for arterial and venous ligation in a porcine model. *J Urol*. 2003;169:697–700.
17. Launois MT, Vandeweerd JMEF, Perrin RAR, Brogniez L, Gabriel A, Coomer R. Evaluation of a vessel-sealing device to assist eye enucleation and exenteration in the horse. *Equine Vet Educ*. 2009;21:596-601.
18. Miller KP, Rekers WL, Lena GDT, Blanchette JM, Milovancev M. Evaluation of sutureless scrotal castration for pediatric and juvenile dogs. *JAVMA*. 2018;253:1589-93.
19. Faluvégi A, Bedi D, Banhidý J, Demeter A, Molnár J, , et al. Neutering of dogs and cats using LigaSure device. *Magyar Állatorvosok Lapja*. 2018;140:217-21.
20. Adin CA. Complications of ovariohysterectomy and orchiectomy in companion animals. *Vet Clin North Am Small Anim Pract*. 2011;41:1023–39.
21. Scott JE, Swanson EA, Pearce EC, Cooley J, Wills RW. Healing of canine skin incisions made with monopolarelectrosurgery versus scalpel blade. *Vet Surg*. 2017;46:520-9.
22. McKenna RJ, Brenner M, Gelb AF, Mullin M, Singh N, Peters H. A randomized prospective trial of stapled lung reduction versus laser bullectomy for diffuse emphysema. *J Thorac Cardiovasc Surg*. 1996;111:317–22.

23. Belch A, Matiasovic M, Rasotto R, Demetriou J. Comparison of the use of LigaSure versus a standard technique for tonsillectomy in dogs. *Vet Rec.* 2016;180:196.
24. Collard F, Nadeau ME, Carmel EN. Laparoscopic splenectomy for treatment of splenic hemangiosarcoma in a dog. *Vet Surg.* 2010;39:870-2.
25. Proença LM. Two-Portal Access Laparoscopic Ovariectomy Using Ligasure Atlas in Exotic Companion Mammals, *Vet Clin North Am Exot Anim Pract.* 2015;18:587-96.
26. Öhlund M, Höglund O, Olsson U, Lagerstedt AS. Laparoscopic ovariectomy in dogs: a comparison of the LigaSure™ and the SonoSurg™ systems. *JSAP.* 2011;52:290-4.
27. Wouters EGH, Buishand FO, Kik M, Kirpensteijn J. Use of a bipolar vessel-sealing device in resection of canine insulinoma. *JSAP.* 2011;52:139-45.
28. Gardeweg S, Bockstahler B, Duprè G. Effect of multiple use and sterilization on sealing performance of bipolar vessel sealing devices. *PLoS One.* 2019;20;14(8):e0221488.

Figures

Figure 1

Surgical procedure. A, Scrotal incision. B Exteriorization of the testicle, spermatic cord exposure and LigaSure activation for hemostasis. C Transection of the spermatic cord with scissors distal to the sealed spermatic cord. D Gentle approximation of the incision edges after stump retraction. E Final aspect of the surgery