ORIGINAL ARTICLE

Surgical technique, complications and follow-up of laparoscopic treatment of prostatic cysts in dogs: 12 cases (2017-2022)

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Objective: To describe the surgical technique, associated complications and 12-month outcomes in dogs that underwent laparoscopic treatment of prostatic cysts.

Materials and Methods: The medical records of dogs with prostatic cysts that were managed laparoscopically between 2017 and 2022 at two referral institutions were retrospectively reviewed. Intra- and post-operative complications were evaluated, and patients were required to have a minimum follow-up of 12 months for inclusion in the study.

Results: Twelve client-owned dogs met the inclusion criteria. A three- or four-port technique was used depending on the surgeon's preference. Following deroofing of the prostatic cyst, urethral integrity was assessed intraoperatively. The cystic cavity was inspected for leakage while injecting saline into the distal urethra, confirming the absence of communication between the urethra and the prostatic cyst. The omentum was anchored to the prostatic body using either simple interrupted sutures or haemostatic clips, with the latter method considered subjectively more challenging by the authors. No major intra- or post-operative complications were reported. Minor intraoperative complications occurred in three of 12 patients, consisting of self-limiting haemorrhage. Minor post-operative complications included one case of transient urinary tenesmus, which resolved within 24 hours, and mild haematuria in one dog, which lasted for 3 days. No recurrence of the prostatic cysts was observed over the 12-month follow-up period.

Clinical Significance: Laparoscopic excision with omentalisation is a feasible, effective and safe therapeutic approach for prostatic cysts in dogs confirmed to lack a communication between the prostatic cyst and the urethra.

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INTRODUCTION

Prostatic cysts (PCs) in dogs manifest as cavitated fluid-filled lesions of varying sizes, enclosed within a distinct fibrocollagenous wall/capsule that may undergo ossification and mineralisation (Bigliardi et al., 2022; Johnston et al., 2000). PCs are uncommon in dogs, accounting for 2.6% to 14% of all prostatic diseases (Palmieri et al., 2022), and are frequently associated with benign prostatic hyperplasia (BPH), which affects more than 80% of intact male dogs older than 6 years

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(Foster, 2012; Krawiec & Heflin, 1992; Levy et al., 2014; Mukaratirwa & Chitura, 2007; Palmieri et al., 2014; Polisca et al., 2015; Smith, 2008).

Descriptions of the classification, pathogenesis and nomenclature of PCs are few and at times conflicting (Palmieri et al., 2022; Smith, 2008; White, 2018). Based on the anatomical location of the cyst relative to the prostatic parenchyma, PCs have been classified as intraparenchymal or prostatic retention cysts (Freitag et al., 2007) and extraparenchymal (Del Magno et al., 2021) or PCs (Barsanti & Finco, 1986; Smith, 2008). However, the generic term PCs has been recommended for describing all types of large discrete cysts affecting the prostate gland (White, 2018).

Clinical signs of PCs usually appear only when the cyst becomes large enough to compress adjacent structures, leading to non-specific signs associated with a caudal abdominal or intrapelvic mass (Barsanti & Finco, 1986). Abdominal distension is the most common presenting sign, followed by urinary incontinence, dysuria and/or faecal tenesmus (Bray et al., 1997; Mukaratirwa & Chitura, 2007). PCs may be up to 30 cm in diameter, which can result in cranial displacement of the gland (Bigliardi et al., 2022; Palmieri et al., 2022). Consequently, digital rectal examination alone cannot be reliably used to diagnose or assess PCs, and diagnostic imaging is required (Mukaratirwa & Chitura, 2007; Palmieri et al., 2022). Ultrasound is the primary modality for diagnosing and evaluating PCs in dogs, enabling efficient prostatic imaging, often without sedation, and guiding percutaneous biopsy or aspiration at the same time (Smith, 2008). CT has also been used in prostatic evaluation, offering high-resolution imaging, beneficial for detecting cyst wall mineralisation and accurately assessing larger cystic cavities, which can be challenging to measure with ultrasound alone (Kuhnt et al., 2017; Lee et al., 2011; Pasikowska et al., 2015). CT measurements of prostatic parenchyma and cyst size showed close agreement with ultrasound results, further supporting ultrasound's reliability in PC assessment (Lee et al., 2011). MRI, though less commonly used in routine prostatic evaluations, provides superior soft-tissue contrast and may aid in complex cases (Yang et al., 2023). Decisions regarding PC treatment are mainly based on cyst size and characteristics, with both ultrasound and CT serving crucial roles in guiding intervention strategies (Levy et al., 2014).

Ultrasound-guided aspiration is the most frequently reported non-surgical treatment for PCs (Bokemeyer et al., 2011; Boland et al., 2003). Boland et al. (2003) reported a 100% success rate in eight cases, achieving resolution after one to four drainage procedures. In a larger study by Bokemeyer et al. (2011), 24% of the 87 treated patients eventually required surgical intervention after initial aspiration. To reduce the risk of cyst recurrence, cystic drainage may be combined with cyst alcoholisation (Bussadori et al., 1999), which demonstrated a 10% relapse rate over a 30-day follow-up period. Alternatively, intracystic injection of platelet-rich plasma has demonstrated a 100% success rate in ten dogs (Bigliardi et al., 2018).

Potential complications of non-surgical treatment include leakage of cyst contents and injected tissue-damaging substances causing abdominal contamination, accidental laceration of adjacent vascular structures and recurrence (Boland et al., 2003; White, 2018). Non-surgical treatment, ideally combined with chemical or surgical castration, may be appropriate for selected patients. This includes dogs that require stabilisation before surgical intervention or are unsuitable for prolonged anaesthesia, and patients in which financial constraints are an issue (White, 2018). Definitive guidelines for patient selection for non-surgical treatment are currently lacking (Del Magno et al., 2021).

Surgery remains the treatment of choice for PCs and is recommended both as the primary treatment and for cases of cyst recurrence after non-surgical interventions (White, 2018). Over the years, various surgical techniques have been described, with partial or complete cyst resection and omentalisation being particularly advocated (Bray et al., 1997; White, 2018; White & Williams, 1995). However, other surgical treatments such as prostatectomy (Rawlings et al., 1997) and prostatic marsupialisation (Hoffer et al., 1977) are now considered outdated and are no longer recommended (White, 2018).

Surgical management has been associated with a recurrence rate ranging from 0% to 33% (Bray et al., 1997; Del Magno et al., 2021; Welsh et al., 2000). A large study on surgical treatment of PCs reported a 6.8% mortality rate. The three reported fatal complications – oliguric kidney injury, cardiac arrhythmia and persistent urinary tract obstruction – occurred in patients who had experienced preoperative urinary tract obstruction (Del Magno et al., 2021). The same study reported an overall minor post-operative complication rate of 22.7%, including urinary incontinence (15.9%) and transient urinary tract obstruction (6.8%) (Del Magno et al., 2021).

The Pubmed database was searched with the following keywords: prostatic cysts, laparoscopy, minimally invasive surgery and dog, on August 1, 2024. The search found two case reports involving a total of three dogs that underwent laparoscopic treatment of PCs (Comas Collgrós et al., 2021; Park et al., 2024).

The aim of this study was to describe the laparoscopic treatment of PCs in 12 dogs and the intra- and post-operative complications after a minimum follow-up period of 12 months.

MATERIALS AND METHODS

Study design and inclusion criteria

The medical record databases of two small animal referral institutions were searched in August 2023 for dogs that underwent laparoscopic treatment of PCs. The software dr.veto (Alcyon) and Provet Cloud (Nordhealth) were searched by the leading investigator from each hospital using the keywords "prostatic cyst", "paraprostatic cyst", "omentalisation", "cyst ablation" and "laparoscopy". Patients with a minimum of 12 months of follow-up were included. The signalment, clinical signs, haematological abnormalities, diagnostic imaging techniques and findings, results of urinalysis and PC fluid analysis, surgical techniques, intra- and post-operative complications, duration of hospitalisation, histopathology results and follow-up were retrieved. Anaesthesia and

surgery times were recorded separately, and if conversion to open surgery was performed, the reason was included.

Preoperative lab tests and imaging

The initial diagnostic workup for most dogs included a complete blood count, serum biochemistry panel, urinalysis and culture of a urine sample collected via ultrasound-guided cystocentesis. The content of the PCs was evaluated cytologically and bacteriologically. Retrograde radiographic or tomographic urography using a contrast medium was performed preoperatively in one and three patients, respectively, to determine whether there was communication between the urethra and the cyst.

Laparoscopic PC resection and omentalisation

All patients underwent general anaesthesia with a premedication protocol tailored to each patient. General anaesthesia was induced with intravenous administration of propofol or alfaxalone and maintained with a mixture of isoflurane and oxygen. Patients were placed in dorsal recumbency in a 15° Trendelenburg position. The urinary bladder was emptied after the insertion of a rigid urinary catheter, which remained in place until the end of the laparoscopic procedure. All surgeries were carried out by a board-certified surgeon (FM, MJP). A three- or four-port technique was used based on the surgeon's preference. In both techniques, the camera port was inserted on the midline, 1 to 2 cm caudal to the umbilicus, and carbon dioxide insufflation was used to establish and maintain a capnopneumoperitoneum at 8 mmHg. In the three-port technique, two additional ports were placed in the right and left abdomen, positioned just caudal to the initial subumbilical port. In the four-port technique, two instrumentation ports were established in the right abdomen just caudal to the first port. The fourth port was situated near the midline region cranial to the endoscope and was used to traction the urinary bladder cranially to facilitate PC visualisation (Fig 1).

After the ports were established, tension on the cyst wall was reduced by draining the PC under laparoscopic guidance using a 22G intravenous catheter of adequate length inserted through the abdominal wall (Fig 2). A window was created in the PC by incising the cystic wall with laparoscopic scissors (STORZ) to facilitate adequate drainage and visualisation of the cyst cavity. The urinary catheter was then withdrawn from the bladder to the penile urethra, and sterile saline was injected through the catheter to determine whether a communication between the urethra and the cyst was present. Visualisation of fluid filling the PC confirmed communication, and conversion to an open procedure was mandatory. When no communication between the PC and urethra was detected, laparoscopic treatment proceeded. The ventral and lateral walls of the PC were resected in their entirety with laparoscopic dissectors (LigaSure™ Maryland Jaw Open alone, or in combination with ENSEAL® Tissue Sealer and STORZ laparoscopic scissors) with special attention to the preservation of the ureters. The omentum was incised sufficiently to extend to the PC and then secured to the body of the prostate gland with hemoclips (Endo Clip 10 mm Medtronic) or by placing one or two interrupted sutures (2-0 or 3-0 polydioxanone) into the prostatic parenchyma (Fig 3). To maintain intra-abdominal pressure, the resected PC was not removed from the abdomen until the end of the procedure. In some cases, a retrieval bag (Endobag, Medtronic) was used to remove the excised tissue; otherwise, it was pulled through the portal access, which was enlarged when necessary. The portal sites were routinely closed. Castration was performed in all patients via a pre-scrotal approach after the laparoscopic procedure. In patient number 2, who was cryptorchid, the right intra-abdominal testicle was removed laparoscopically following PC treatment and the left testicle was removed through a pre-scrotal incision. The rigid urinary catheter was removed at the end of the procedure. In the two dogs with a history of

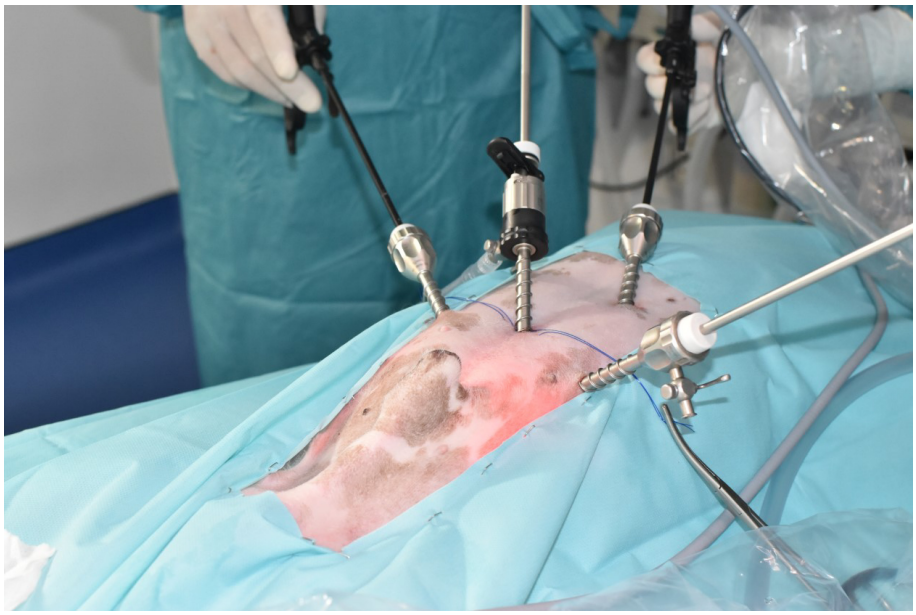

FIG 1. Ports' placement in the four-port technique.

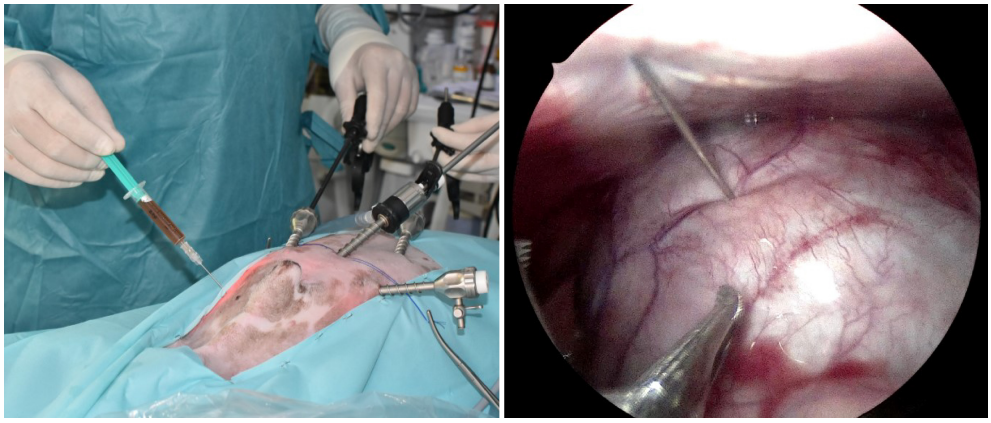

FIG 2. Intraoperative cyst draining under laparoscopic guidance.

urinary tenesmus, a Foley catheter was placed before they recovered from anaesthesia.

Complications

Complications were recorded separately as intra- or post-operative. Intraoperative complications were classified as minor when they could be managed laparoscopically and major when conversion to an open procedure was necessary. Post-operative complications were categorised as minor when they required no intervention or medical treatment alone and major when surgical intervention was required.

Histopathology and follow-up

A sample of the cyst wall was submitted for bacteriological culture and sensitivity. All remaining excised tissues were immersed in a 10% buffered formalin solution and submitted for histopathological examination. All dogs underwent a focal ultrasonographic evaluation of the urinary tract 6 months post-operatively. The ultrasound follow-up aimed to assess the presence of residual or recurrent PCs, the presence of free abdominal fluid and the identification of new prostatic abnormalities. Additionally, a telephone follow-up was conducted at the time this study was designed in August 2023. The telephone follow-up intended to gather information regarding the patients' recovery, the presence of urinary clinical signs (*e.g.* incontinence, haematuria and tenesmus) and any complications experienced post-operatively.

Data analysis

Data were reported as median and range (minimum to maximum value).

RESULTS

Study population and preoperative clinical signs

Twelve client-owned dogs were included in the study. Signalment and preoperative clinical signs are listed in Table 1. All dogs were intact males, one of which was a cryptorchid, and the mean age was 8 years (range, 6 to 12 years). Breeds included American Staffordshire terrier (two), boxer (two), German shepherd dog (two), Australian shepherd dog (one), crossbred (one), English Setter (one), French Bulldog (one), golden retriever (one) and Rottweiler (one). Faecal tenesmus was the most common clinical sign (4/12), followed by pollakiuria (3/12). Other clinical signs included dysuria (1/12), urinary incontinence (1/12), stranguria (1/12), haematuria (1/12), lethargy (1/12), abdominal pain (1/12), and polyuria and polydipsia (1/12). Two patients had no clinical signs, and the PC was an incidental finding (Table 1).

Preoperative lab tests and imaging

Most patients had no major haematological or serum biochemical abnormalities. Elevated liver enzymes were noted in patient number 3, who had a hepatic tumour. Of the 12 dogs, 11 showed no overt azotaemia, though a mild increase in urea was observed in patient 5. Additionally, three patients (7, 10 and 12) had mild to moderate neutrophilic leucocytosis. Patient number 12 also had a mild increase in blood glucose, total protein and albumin concentrations. Urine culture was positive for *Escherichia coli* in patient number 5 and *Klebsiella pneumoniae* in patient number 8; the remaining ten dogs had negative urine culture results. Based on the culture and sensitivity results, a 2-week course of antibiotics was administered in dogs with urinary tract infection, and surgery was delayed until a negative urine culture was obtained after antibiotic treatment. Culture of PC fluid was performed in all dogs except for patient 4, and all results were negative. The ratio of creatinine concentration in PC fluid and peripheral blood was measured in patients 2 and 6 and was 0.34 (0.28:0.82) and 0.55 (0.53:0.96), respectively.

One or more imaging techniques were used for preoperative assessment of the PCs. Radiographs were obtained in three of the 12 patients, and 11 of the 12 patients underwent abdominal ultrasonography. Patient number 4 had an abdominal mass detected on radiographs at the referring clinic and underwent CT alone. Nine of the 12 patients underwent CT after abdominal ultrasonography; the owners of patients 1, 7 and 11 declined CT for financial reasons. A solitary PC was diagnosed in nine of the 12 patients, while two patients had two cysts and one patient had three cysts. The size of the PC was determined using different techniques, yielding a median measurement of 6.95 × 4.05 × 6.49 cm. In patient number 1, retrograde contrast

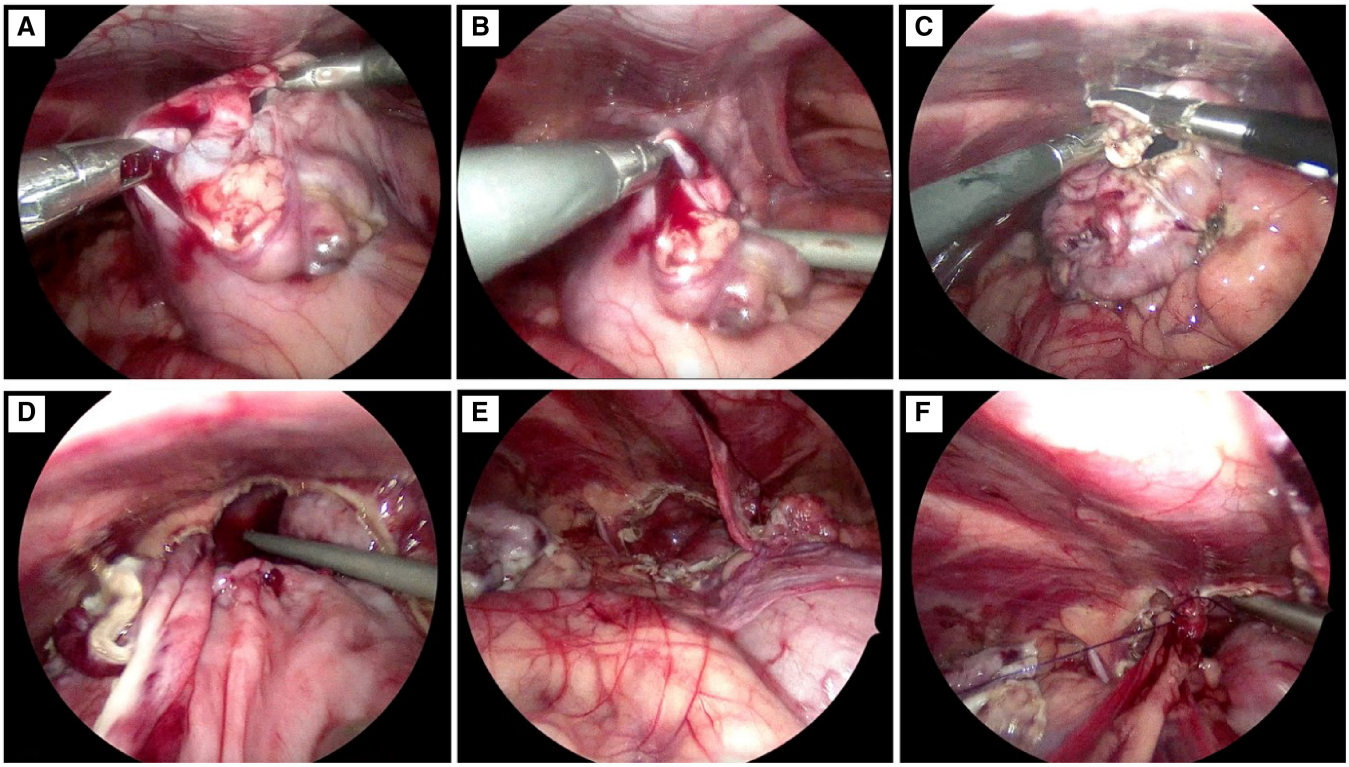

FIG 3. Laparoscopic procedure images: after draining the cystic content, the cystic wall was elevated and sharply incised with laparoscopic scissors (A). The remaining fluid was aspirated with a laparoscopic aspirator (B). The cystic wall was transected with laparoscopic bipolar vessel-sealing devices (LigaSure™ Maryland Jaw Open) (C). A urinary catheter placed within the urethra was flushed to facilitate observation for PC-urethral communications (D, E). Omentum was then dissected, retracted and clipped or sutured to the prostatic parenchyma (F).

urethrography was assessed radiographically, while CT was used in patients 2, 4 and 6 (Table 1).

Laparoscopic PC resection and omentalisation

Eight dogs were treated with a three-port technique and four dogs with a four-port technique. The overall median surgical time was 54.5 minutes with no significant difference between the three- (56 minutes) and four-port (52 minutes) techniques. The overall median anaesthetic time was 105 minutes, with a mild difference between the three- (96 minutes) and four-port (114 minutes) techniques. The LigaSure (LigaSure™ Maryland Jaw Open) was the vessel-sealing device most commonly used. The ENSEAL (ENSEAL® Tissue Sealer) was used in only two cases. Intraoperative urinary hydropulsion confirmed the absence of communication between the urethra and the PCs in all patients. Thus, none of the laparoscopic surgeries required conversion to an open approach. A single cryptorchid patient required laparoscopic removal of the right testicle. The left testicle of the cryptorchid patient and all other dogs underwent routine closed pre-scrotal castration. Patients were hospitalised for 24 to 72 hours with a median of 38 hours. A Foley urinary catheter was placed in two patients with a preoperative history of urinary tenesmus and in patient number 4, who developed urinary tenesmus 1 hour after recovery from the procedure. The catheters were removed at 6, 12 and 24 hours post-placement (Table 2).

Complications

No major intraoperative complications were recorded. However, minor intraoperative complications occurred in three of the 12 cases. Patients 5 and 8 had minor, self-limiting, prostatic haemorrhage. Patient number 3 also underwent a liver lobectomy during the same laparoscopic procedure and had minor, self-limiting haemorrhage from the liver.

Major post-operative complications were not encountered. Minor post-operative complications were reported in two of the 12 cases. In patient number 4, transient urinary tenesmus was observed immediately after surgery, and a Foley urinary catheter was placed 1 hour after recovery from surgery. The catheter was removed 24 hours later, and urinary tenesmus resolved without the need for further treatment. Patient number 12 had mild haematuria in the recovery period, which resolved within 3 days of surgery. Though the patient had a negative preoperative urine culture, a 7-day course of marbofloxacin was prescribed empirically to prevent secondary infection.

Histopathology and follow-up

Histopathological evaluation showed benign PCs in 11 of the 12 patients. A single dog, patient number 5, had a histopathological diagnosis of prostatic adenocarcinoma. The long-term follow-up period ranged from 480 to 2490 days with a mean of 1505 days (4 years). The ultrasonographic follow-up examination 6 months post-operatively revealed no evidence of PC recurrence, the

Table 1. Patient demographics; preoperative blood, urine and culture test results, and diagnostic imaging findings

Study population and clinical signs					Preoperative analyses			Preoperative imaging	
Case	Breed	Sex	Age (y)	Clinical signs	Bloods	Urinalysis and culture	Cyst analysis	Radiographs	AUS	CT
1	German shepherd, M, 8 years	M	8	Dysuria, pollakiuria	Within normal limits	Normal, negative	Fluid content Negative culture No neoplastic cells	Radiopaque mass caudal abdomen Retrograde contrast urethrogram negative for communication with urethra	Solitary PC 5×3 cm	Not performed
2	Boxer	M	4	Pollakiuria	Within normal limits	Normal, negative	Fluid content Negative culture No neoplastic cells	Radiopaque mass caudal abdomen	Solitary PC 10 cm in diameter	PC 10×13×13 cm. Abdominal location of right testicle Retrograde contrast urethrogram negative for communication with urethra
3	Australian shepherd	M	8	Urinary incontinence	ALP 134 ALT 117 AST 36	Normal, negative	Fluid content Negative culture No neoplastic cells	Not performed	Solitary PC 3 cm+ Left liver nodule	PC 4.5×3×3 cm left liver nodule 2×4 cm (liver cytology = adenoma *vs.* adenocarcinoma)
4	German shepherd	M	10	Stranguria faecal tenesmus	Within normal limits	Normal, negative	Not performed	Caudal abdominal mass	Not performed	PC 13×4.7×3.9 Retrograde urethrogram negative
5	American Staffordshire terrier	M	8	Pollakiuria	BUN 54	Positive: *Escherichia coli*	Cytology compatible with prostatitis Culture negative but under amoxicillin/clavulanate	Not performed	Performed by the RVS	PC presence was confirmed, measuring 2.6×3.1 cm
6	English Setter	M	9	Faecal tenesmus	Within normal limits	Normal, negative	Fluid content Negative culture No neoplastic cells	Not performed	Performed by RVS	PC 13 ×10 ×6.5 cm right testicle nodule Retrograde contrast urethrogram negative for communication with urethra
7	Crossbreed	M	6	Haematuria, lethargy	LEU 27 k/μL Neu 23 k/μL	Normal, negative	Fluid content Negative culture No neoplastic cells	RVS referred for radiopaque mass in caudal abdomen	2 PC 2 ×3 and 1 ×4 cm	Not performed
8	Boxer	M	6	None	Within normal limits	Positive: *Klebsiella pneumoniae*	Fluid content Negative culture No neoplastic cells	RVS referred for radiopaque mass in caudal abdomen	Confirmation PC presence 6 ×7 cm	PC 6 ×5 ×7 cm
9	Golden retriever	M	12	None	Within normal limits	Normal, negative	Fluid content Negative culture No neoplastic cells	RVS referred for radiopaque mass in caudal abdomen	Confirmation PC presence 10 cm diameter	Right PC 11 ×9 ×11 cm
10	American Staffordshire terrier	M	6	Faecal tenesmus, abdominal pain	LEU 16.78 k/μL	Normal, negative	Fluid content Negative culture No neoplastic cells	RVS referred for radiopaque mass in caudal abdomen	3 PC cysts	Right PC of 2.2×2.9×3.7 cm Left PC 4×6.5×10.5 cm Third cyst 2×1.5×5.4 cm Mild sublumbar lymphadenomegaly
11	French Bulldog	M	10	None	Within normal limits	Normal, negative	Fluid content Negative culture No neoplastic cells	RVS referred for radiopaque mass in caudal abdomen	Right-sided PC 3×4cm	Not performed
12	Rottweiler	M	7	Faecal tenesmus, polyuria, polydipsia	LEU 26.43 k/μL NEU 20 k/μL GLU 145 g/dL TP 8.2 g/dL ALB 4.5 g/dL PAL 642 U/l	Normal, negative	Fluid content Negative culture No neoplastic cells	RVS referred for radiopaque mass in caudal abdomen	2 PC	Left-sided PC 5×4×10 cm right-sided PC 2.8×1.5×3 cm Mild mesenteric lymphadenomegaly

CT Computed tomography, AUS Abdominal ultrasound, M Male, y Years, ALP Alkaline phosphatase, ALT Alanine transaminase, AST Aspartate aminotransferase, LEU Leucocyte, NEU Neutrophils, GLU Glucose, RVS Referring veterinary surgeon, TP Total protein, ALB Albumin

Table 2. Summary of surgical details, including surgical technique, anaesthesia and surgical duration, omentalisation technique, concomitant procedures, intraoperative and post-operative complications, hospitalisation time, histopathology results and last follow-up findings

Surgery details						Complications			Post-operative		
Case	Surgical technique	Surgical time	GA time	Omentalisation	Concomitant procedure	Intraoperative complication	Post-operative complications	Hospitalisation time (hours)	Histopathology	Last follow-up findings	FU (days)
1	3-port technique	50′	80′	With clips	Castration	Difficult to clip the omentum to the cyst remnant	None	48	PC	No clinical signs of recurrence of PC	2430
2	3-port technique	65′	110′	With intracorporal sutures	Castration (laparoscopic removal of the right cryptorchid testicle)	None	None	48	PC	No clinical signs of recurrence of PC	1470
3	3-port technique	80′	120′	With clips	Castration + left liver lobectomy	Minor haemorrhage from liver lobe	None	72	PC + liver low-grade hepatocellular carcinoma	No clinical signs of recurrence of PC Recurrence of liver tumour, surgically removed 3 years later	1380
4	3-port technique	65′	110′	With intracorporal sutures	Castration	None	Minor: temporary tenesmus, which resolved with 24 hours of catheterisation	48	PC	No clinical signs of recurrence of PC	1170
5	3-port technique	30′	70′	With intracorporal sutures	Castration	Minor haemorrhage from prostate	None, preventive 12 hours of catheterisation	48	Prostatic adenocarcinoma	No clinical signs of recurrence of PC Euthanased 1 year after diagnosis of prostatic adenocarcinoma	990
6	3-port technique	50′	90′	With intracorporal sutures	Castration	None	None, preventive 6 hours of catheterisation	48	PC + bilateral testicular seminoma	No clinical signs of recurrence of PC	720
7	4-port technique	40′	120′	With intracorporal sutures	Castration	None	None	24	PC	No clinical signs of recurrence of PC	2190
8	4-port technique	45′	110′	Not performed	Castration	Minor haemorrhage from prostate	None	24	PC	No clinical signs of recurrence of PC	660
9	4-port technique	55′	130′	Not performed	Castration	None	None	24	PC	No clinical signs of recurrence of PC	480
10	4-port technique	73′	120′	With intracorporal sutures	Castration	None	None	24	PC	No clinical signs of recurrence of PC	1710
11	4-port technique	42′	110′	With intracorporal sutures	Castration	None	None	24	PC	No clinical signs of recurrence of PC	2370
12	4-port technique	60′	95′	With intracorporal sutures	Castration	None	Minor: self-limiting haematuria	24	PC	No clinical signs of recurrence of PC	2490

H Hours, ′ Minutes, GA General anaesthesia, FU Days between surgery and last available follow-up

presence of free abdominal fluid and the presence of new prostatic conditions in all patients except one. In patient number 5, progression of prostatic adenocarcinoma was noticed, characterised by an increase in volume and heterogeneity of the prostatic parenchyma. In August 2023, 11 of the 12 patients completed a telephone follow-up. The follow-up was not conducted for patient number 5, who died 1 year after surgery for prostatic adenocarcinoma. Based on the follow-up, none of the patients showed clinical signs suggestive of PC recurrence, including urinary incontinence, haematuria or tenesmus.

DISCUSSION

Laparoscopic treatment for PCs was first described in a dog in 2021 (Comas Collgrós et al., 2021) and more recently in two other dogs (Park et al., 2024). Based on the literature search, this is the first study describing the safety and feasibility of this technique, including the 12-month outcome in a larger cohort of dogs. In human medicine, minimally invasive surgical techniques (robotic-assisted laparoscopic surgery) are the gold standard for the treatment of prostatic conditions (Homer et al., 2024). Laparoscopic treatment can be particularly beneficial for managing prostatic lesions in dogs because the location of the gland in the caudal abdomen makes visualisation through traditional abdominal surgery challenging. The largest study on PCs to date reported that a combined abdominal and perineal approach was required in 9.3% of patients because the intrapelvic location of the cyst was too far caudal to be safely treated through an abdominal approach alone (Del Magno et al., 2021).

Although laparoscopic treatment of PCs is often beneficial, it is contraindicated in certain situations. For example, in dogs with communication between the PC and urethra, laparoscopic treatment increases the risk of uroabdomen. Thus, the authors recommended performing preoperative retrograde urethrography using radiography, CT or ultrasonography to exclude communication. In addition, intraoperative monitoring of the deroofed PC while flushing the urethra through a urinary catheter inserted into the penile urethra is warranted. The use of the prostatic fluid:serum creatinine ratio has been used as a parameter for diagnosing the presence of urine in PCs. A ratio >2:1 is considered positive for the presence of urine in the prostatic lesion (Bokemeyer et al., 2011). Although this parameter was only measured in two of our patients, it may be useful in future preoperative screening protocols. The second possible contraindication for laparoscopic treatment of PCs is infection of the cyst or cyst abscessation. As the aspiration of fluid from prostatic abscesses carries a risk of causing iatrogenic septic peritonitis (Boland et al., 2003; Freitag et al., 2007), laparoscopic treatment of an infected cyst may increase the risk of septic peritonitis. The third contraindication is PC herniation through a fragile pelvic diaphragm, which would require a perineal approach, and pelvic diaphragm repair would be combined with PC treatment (Del Magno et al., 2021).

No major complications occurred in the present study. In a recent report in which an open approach was used (Del Magno et al., 2021), one major intraoperative complication occurred in 44 patients and 9% of dogs had a fatal complication in the post-operative period. Of the latter, three of four dogs that died had preoperative urinary tract obstruction and acute kidney injury, which did not occur in any of our patients. Minor intraoperative complications occurred in three of our 12 patients, but conversion to open surgery was not required. One of the three intraoperative complications was not related to PC treatment but rather entailed minor, self-limiting, hepatic haemorrhage secondary to the concurrently performed laparoscopic liver lobectomy. The remaining two minor intraoperative complications were directly related to PC treatment and involved self-limiting prostatic haemorrhage. Omentalisation using hemoclips instead of sutures was challenging. Laparoscopic 10 mm hemoclips (Endo Clip 10 mm Medtronic) were unsatisfactory for anchoring the omentum to the prostatic parenchyma, and multiple attempts were required to achieve the desired result. Based on the authors' personal experience, it is easier to secure the omentum to the prostatic parenchyma with one or two simple interrupted intracorporeal sutures. The authors used 2-0 or 3-0 polydioxanone; however, barbed suture material may also be suitable and could help reduce surgical time, particularly for surgeons less confident in laparoscopic knot tying. Other types of clips, which may facilitate faster omental attachment, were not utilised in this study.

Urinary retention and incontinence are the most commonly reported complications of prostatic surgery (Freitag et al., 2007; White & Williams, 1995). Urinary incontinence, which can be transient and self-resolving or permanent (Freitag et al., 2007), results from iatrogenic damage to the neural supply to the bladder neck. A higher incidence of urinary incontinence is associated with PCs located in the dorsolateral area of the prostate (L'Eplattenier, 2016). It has also been suggested that post-operative urinary incontinence may be associated with a compromised neural component attributable to chronic traction from very large PCs (Bray et al., 1997). The development of urinary incontinence several months after surgery has been reported, suggesting that post-operative incontinence may not always be caused by the surgical technique (L'Eplattenier, 2016). In our cohort of dogs, none had urinary incontinence, which may have been attributable to careful selection of cases and to peripheral dissection of the cystic wall without the need for bladder neck traction. One of our 12 patients had transient urinary tenesmus after surgery, requiring placement of a urinary catheter 1 hour post-operatively. The tenesmus resolved 24 hours later, and the catheter was removed. The brief duration of the tenesmus may have been secondary to mild neuropraxia associated with a reaction to resection of the PC wall, or the result of mild urethritis caused by placement of a rigid catheter during surgery. Another patient had post-operative haematuria; accidental iatrogenic damage to the urinary bladder during manipulation is considered the most likely cause of post-operative haematuria. Haematuria might have been a result of catheterisation or underlying BPH (Palmieri et al., 2022; Polisca et al., 2015). Comparison of the surgical and anaesthetic times among the three- and four-port techniques was not possible because the sample size was small and some patients underwent concurrent procedures during the same anaesthetic session.

The recurrence rate reported for surgical treatment of PCs varies from 0% to 33% (Bray et al., 1997; Del Magno et al., 2021;

Welsh et al., 2000). PCs did not recur in the 12 dogs included in our study. However, while that was objectively monitored via ultrasonographic assessment 6 months post-operatively, subsequent follow-up was based on clinical signs and the owner's assessments only. The relatively short-term follow-up period may have also contributed to no recurrences.

The main limitation of this study was its retrospective nature. This prevented standardisation of a preoperative diagnostic protocol and the surgical technique, and thus, three- and four-port laparoscopic approaches were used, which may have affected complication rates. A standardised post-operative follow-up was also not achievable. It would have been better to correlate the absence of clinical signs with no recurrence of the PCs using serial post-operative ultrasonographic assessments at fixed intervals. The retrospective design may have led to selection bias, incomplete data collection and reliance on existing medical records, all of which could have affected the accuracy and consistency of the reported outcomes. Another main limitation of this study was the small sample size, which prevented us from drawing conclusions on the results including complication and recurrence rates.

Conventional open abdominal surgical treatment of PCs has been largely explored in the literature. However, the laparoscopic approach requires further studies to determine the intra- and post-operative complication rates as well as the recurrence rate associated with this treatment.

In conclusion, this case series showed that laparoscopic excision with omentalisation of PCs is feasible and represents an effective and safe therapeutic approach, provided that preoperative and intraoperative assessments confirm the absence of communication between the cyst and the urethra.

Author contributions

F. Massari: Conceptualization (equal); data curation (supporting); project administration (lead); writing – review and editing (supporting). **S. Monti:** Conceptualization (supporting); data curation (lead); supervision (equal); writing – original draft (lead); writing – review and editing (lead). **M. Jiménez Peláez:** Writing – review and editing (supporting).

Conflict of interest

None of the authors of this article have a financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

Data Availability Statement

All data analyzed during this study are included in this published article.

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