

Submitted: 20/07/2023

Accepted: 18/09/2023

Published: 31/10/2023

Clinical signs associated with prostatic disorders in canines: Retrospective study in Uruguay (2011–2019)

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Abstract

Background: Prostate disease represents about 0.7% of diseases in canines. The main diagnosed pathology is benign prostatic hyperplasia (BPH). However, the reports that study the association of a certain clinical sign with a specific prostate disease are scarce.

Aim: The main objective of this study was to evaluate the clinical relevance of the most commonly observed clinical signs associated with the different prostatic disorders in canines admitted to the hospital of the Facultad de Veterinaria–Universidad de la República between 2011 and 2019.

Methods: This retrospective study included 7,729 male canines treated at the hospital de la Facultad de Veterinaria–Universidad de la República (Montevideo, Uruguay) between 2011 and 2019. 289 canines with a presumptive/definitive diagnosis of prostate diseases were selected, recording the presence/absence of associated clinical signs. Results were reported in terms of odds ratios (ORs) using logistic regression ($p < 0.05$).

Results: The five most frequently reported clinical signs were tenesmus (34%), anorexia (32%), lethargy (27%), prostatomegaly or pain during rectal examination (25%), and abdominal pain from palpation (22%). Diarrhea (3.39 vs. 0.33 OR), anorexia (2.07 vs. 0.39 OR), weight loss (2.27 vs. 0.27 OR), hematuria (3.25 vs. 0.44 OR), and urinary incontinence (2.96 vs. 0.33 OR) indicated a highest predictive value ($p < 0.05$) with prostatitis versus BPH, respectively. Being weight loss, the clinical sign is more frequently associated with neoplasia (20.2 OR, $p = 0.002$).

Conclusion: This study shows that there are clinical signs with a higher degree of association for certain canine prostatic disorders than others.

Keywords: Canine, Clinical signs, Odds ratio, Prostatic diseases.

Introduction

The prostate is the only accessory sex gland of the canine reproductive system (Christensen, 2018). In non-castrated male canines, the weight and size of the gland gradually increase with age, and for this reason, the disorder manifests itself in canines older than 6 years (Barsanti and Finco, 1986; Smith, 2008). Testosterone has a key role in the development and predisposition of prostate diseases (Cunto *et al.*, 2019). A fact that highlights the role of testosterone in canine prostatic disorders is that the sharp drop in this hormone in the first week post-castration is accompanied by a significant decrease in the volume and prostatic dimensions assessed by ultrasound (Cazzuli *et al.*, 2022).

Although information on prostatic disorders is abundant (Smith, 2008; Christensen, 2018; Cunto *et al.*, 2019;

Cunto *et al.*, 2022), there is not much information from population studies on the prevalence of these disorders in canines (Krawiec and Heflin, 1992; Polisca *et al.*, 2016). In canines, a retrospective study conducted by Polisca *et al.* (2016) in France, showed that benign prostatic hyperplasia (BPH) was the most common prostatic disorder (50%), followed by prostatitis (38.5%). Other prostatic disorders, such as abscesses, neoplasia, cysts, and squamous metaplasia (SM), are usually present, although less frequently (Barsanti and Finco, 1986; Polisca *et al.*, 2016; Cunto *et al.*, 2019). Although biopsy for histopathology is necessary for the definitive diagnosis of these pathologies (Palmieri *et al.*, 2022), it is not always used because it is a very invasive technique (Smith, 2008). In this sense, the combination of fine needle aspiration cytology and B-mode ultrasonography has been reported to have high

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diagnostic value in prostatic disorders (Rodak *et al.*, 2018). The presumptive diagnosis of prostatic disorders can be reached based on the anamnesis, clinical signs, physical examination, ultrasound findings, and laboratory findings such as serum biochemistry, complete blood count, biomarkers, and semen evaluation (Ruetten *et al.*, 2021; Cunto *et al.*, 2022). Canine prostatic disorders can share many clinical signs, including tenesmus, flattened stools, hematuria, and blood dripping from the urethra (Ruetten *et al.*, 2021), which makes the etiological diagnosis based solely on clinical signs difficult (Christensen, 2018; Cunto *et al.*, 2019). Polisca *et al.* (2016) observed that in animals with prostatitis/prostatic abscesses and neoplasia, urinary, systemic, and gastrointestinal signs occurred more frequently compared to animals with BPH. However, to the best of our knowledge, no studies have determined the degree of association (odd ratio) of clinical signs in relation to each of the canine prostatic disorders.

We hypothesize that the clinical signs are associated with the diagnosis of each prostatic disorder, evidencing a lower probability of observing clinical signs such as tenesmus, anorexia, hematuria, urinary incontinence, lethargy, pain on abdominal, and/or rectal palpation in BPH than in prostatitis. Therefore, the objective of this study was to evaluate the clinical relevance of the main signs associated with the different prostatic disorders in canines who were admitted to the hospital of the Facultad de Veterinaria–Universidad de la República (FVET–UdelaR) between 2011 and 2019. As a secondary objective, we set out to describe the prevalence of each prostatic disorder, age, body size, and reproductive status (neutered vs. non-neutered) in the canine population with prostatic disease studied during the same period.

Materials and Methods

Medical records

This is a retrospective study. All records (clinical records) of canines admitted at the Hospital of the Facultad de Veterinaria–Universidad de la República (Montevideo, Uruguay) between 2011 and 2019 were reviewed.

Inclusion criteria

First, all the medical records that matched the following inclusion criteria were selected: species (canine), sex (male), presumptive or definitive diagnosis of prostatic disorder. The presumptive diagnosis of a prostatic disorder was reached when the patient had an anamnesis, clinical signs, and clinical examination consistent with said prostatic disorder (Smith, 2008; Lévy *et al.*, 2014; DiBartola and Westropp, 2019), laboratory findings (e.g., blood biochemistry, urinalysis, urine culture, and prostate cytology) consistent with the suspected disorder (Zinkl, 2008; Teske, 2009; Lacreta *et al.*, 2012) and B-mode ultrasonography of the prostate to assess echostructure of the parenchyma and

dimensions compatible with a disorder (Mattoon and Davidson, 2020). No patient had a prostatic biopsy. A definitive diagnosis of a prostatic disorder was considered when the patient had a cytological report by fine needle aspiration added to a B-mode ultrasound image compatible with said prostatic disorder (Rodak *et al.*, 2018). Only the cases of SM and prostatic neoplasia (PN) were considered definitive diagnoses based on anamnesis, clinical signs, laboratory findings, ultrasound images, and compatible cytology. The remaining diagnoses were presumptive. All the canines included in this study received treatment for the diagnosed prostatic disorder, confirming clinical improvement in all cases. From these records, other specific descriptive data were recorded, including age, breed, size, reproductive status (castrated/non-castrated), the reason for consultation, anamnestic data provided by the owner, clinical signs, complementary tests performed, and description of the ultrasound study. In this study, the inclusion of the breed variable was disregarded since 87% of the medical records belonged to mongrel animals, or the breed was not determined.

Classification of physiological variables

Age was reported in years. The size was grouped into three categories: <10 kg (small size), ≥10, and ≤25 kg (median size); >25 kg (large size), according to what was reported by Ruel *et al.* (1998).

Description of the reported clinical signs

The clinical signs recorded in patients with a presumptive or definitive diagnosis of prostatic disorder were grouped based on Polisca *et al.* (2016) but with modifications, in three categories: digestive signs (tenesmus, flat stools, constipation, vomiting, diarrhea, hematochezia, dyschezia, anorexia, and weight loss); urinary signs (hematuria, blood dripping from the urethra, pollakiuria, stranguria, dysuria, anuria, urinary incontinence, and polyuria/polydipsia); and “other signs” (presence or absence of hindlimb weakness, difficulty with locomotion, perineal hernia, abdominal pain from palpation, prostatomegaly or pain during rectal examination, and lethargy).

Classification of the different prostatic disorders

The following five prostatic disorders were considered: BPH, with and without the presence of cysts according to the ultrasound report; prostatitis, SM; PN; and paraprostatic cysts (PCs). These prostatic disorders were defined according to anamnesis, clinical signs, physical examination, laboratory findings, and B-mode ultrasonography compatible with each disorder, already described in the inclusion criteria. B-mode ultrasound evaluations consisted of abdominal and pelvic examinations to locate the bladder and, subsequently, to identify the prostate. Images were captured to determine prostate volume by the ellipse formula: length × width × height × 0.523 (Ruel *et al.*, 1998; Cazzuli *et al.*, 2022). In the sagittal position, the length was measured as the maximum diameter of

the gland along the urethral axis and the height as the maximum diameter perpendicular to the length axis. In the transverse position, the width was measured as the maximum diameter from the prostate measured from right to left (Mattoon and Davidson, 2020). Prostatic disorders that occurred infrequently ($\leq 5\%$) were excluded from further analysis.

Statistical analysis

The prevalence (%) of prostatic diseases in the study population was defined by the number of canines (n) that experienced a prostatic disorder in relation to the total number of canines admitted in the hospital of the FVET–UdelaR consultation during the researched period. The prevalence (%) of different prostatic disorders was calculated as the number of canines experiencing a diagnosed prostatic disorder (BPH, prostatitis, SM, PN, and PC) relative to the total number of canines that were recorded with prostatic diseases. Statistical differences in age, size, and neutering by prostatic disorder were calculated using the Kruskal-Wallis rank sum test or Fisher's exact test. The associations of clinical signs with each prostatic disorder (BPH, prostatitis, and PN) were examined using multiple logistic regression analysis (explanatory variables: digestive, urinary, or other signs). The results were reported in terms of frequency (%), odds ratios (ORs), 95% confidence interval (CI), and p -value (<0.05 was considered significant). All analyses were performed in R (Version 4.2.2, 2022) and Rstudio (version 2022.12.0 Build 353) (Rstudio Team, 2022).

Ethical approval

Not needed for this study.

Results

Population data

Of the total medical records ($n = 7729$) in 9 years of care at the hospital of the FVET–UdelaR, the recorded prostatic disease prevalence was 3.7% ($n = 289$). The prevalence of different prostatic disorder was greater for BPH 71.6% ($n = 207$), followed by prostatitis 23.5% ($n = 68$), PN 3.1% ($n = 9$), PC 1.3% ($n = 4$), and SM 0.3% ($n = 1$) (Chi-Square 1,796, $df 5$, $p < 0.01$). In turn, 66% of the BPH cases had cystic structures present.

The average age of presentation of the prostatic disease was 10 years (ranging from 3 to 15 years), with 62% ($n = 126$) corresponding to animals of large size, 27% ($n = 55$) to animals of medium size and 11% ($n = 23$) to animals of small size. 99% of canines ($n = 280$) were linked to a non-castrated reproductive status. Table 1 shows that prostatic disorders had no association with the variables age (Kruskal-Wallis, $p = 0.81$), size (Fisher's exact test, $p = 0.51$), and castrated or non-castrated status (Fisher's exact test, $p = 0.23$).

Table 2 indicates the frequency of clinical signs within each explanatory variable (digestive, urinary, or other signs) for all canines registered with prostatic disease without considering the diagnosed prostatic disorder ($n = 289$). In the set of explanatory variables, the most relevant clinical signs ($>20\%$) in order of frequency of presentation were tenesmus, anorexia, lethargy, prostatomegaly, abdominal pain from palpation, and perineal hernia.

Prostatic disorder and clinical signs observed

Of the 289 canines evaluated, there were 28 individuals with a diagnosis of prostatic disease but with no clinical signs. Of those with clinical signs ($n = 261$), digestive (48%, 45%, 52%), urinary (18%, 19%, and 6%), and

Table 1. Prostatic disorders (BPH, prostatitis, PN, SM, and PC) in canines from the retrospective study (2011–2019) according to age, size (<10 kg; ≥ 10 and ≤ 25 kg; and >25 kg), and neutering (castrated/non-castrated).

Characteristic	N	Prostatic disorder					p-value ^b
		BPH, N = 207 ^a	Prostatitis, N = 68 ^a	PN, N = 9 ^a	SM, N = 1 ^a	PC, N = 4 ^a	
Age	289	10.0 (3.0, 15.0)	10.0 (3.0, 15.0)	10.0 (3.0, 17.0)	15.0 (15.0, 15.0)	8.0 (2.5, 13.3)	0.81 ^b
Size	204						0.51 ^c
<10 kg		15 (10%)	8 (16%)	0	0 (0%)	0 (0%)	
10–25 kg		34 (24%)	17 (33%)	3 (50%)	0 (0%)	1 (33%)	
>25 kg		94 (66%)	26 (51%)	3 (50%)	1 (100%)	2 (67%)	
Unknown		64	17	3	-	1	
Neutering	284						0.23 ^c
Castrated		2 (1.0%)	1 (1.5%)	1 (11%)	0 (0%)	0 (0%)	
Non-castrated		200 (99%)	67 (99%)	8 (89%)	1 (100%)	4 (100%)	
Unknown		5	-	-	-	-	

Prostatic disorder: BPH = benign prostatic hyperplasia; PC = paraprostatic cysts; PN = prostatic neoplasia; SM = squamous metaplasia and .

^aMedian (IQR); n (%).

^bKruskal-Wallis rank sum test.

^cFisher's exact test.

Table 2. Frequency of clinical signs (%) by explanatory variable (digestive, urinary, and others) in canines with prostatic disease in the retrospective study (2011–2019).

Signs observed in prostatic disease	
Clinical signs	N = 289 ^a
Digestive signs	
Tenesmus	97 (34%)
Anorexia	92 (32%)
Weight loss	54 (19%)
Constipation	50 (17%)
Hematochezia	38 (13%)
Vomiting	35 (12%)
Diarrhea	35 (12%)
Dyschezia	7 (2.4%)
Flat stools	7 (2.4%)
Urinary signs	
Polyuria/polydipsia	43 (15%)
Hematuria	33 (11%)
Blood dripping from the urethra	22 (7.6%)
Dysuria	20 (6.9%)
Urinary incontinence	18 (6.2%)
Pollakiuria	13 (4.5%)
Anuria	6 (2.1%)
Stranguria	4 (1.4%)
Others signs	
Lethargy	77 (27%)
Prostatomegaly or pain during rectal examination	72 (25%)
Abdominal pain from palpation	64 (22%)
Perineal hernia	58 (20%)
Hind limb weakness	39 (13%)

^an (%).

other signs (35%, 36%, and 42%) were more prevalent for BPH, prostatitis and PN, respectively.

The main clinical signs of BPH, prostatitis, and PN are shown in Figures 1,–3. These three figures demonstrate a wide range of clinical signs associated with the three main prostatic disorders. Digestive signs were the most frequent for BPH (Fig. 1). Of the digestive signs, the most frequent clinical signs in BPH were tenesmus, followed by anorexia, constipation, and hematochezia. The “other signs” category was also frequent, with

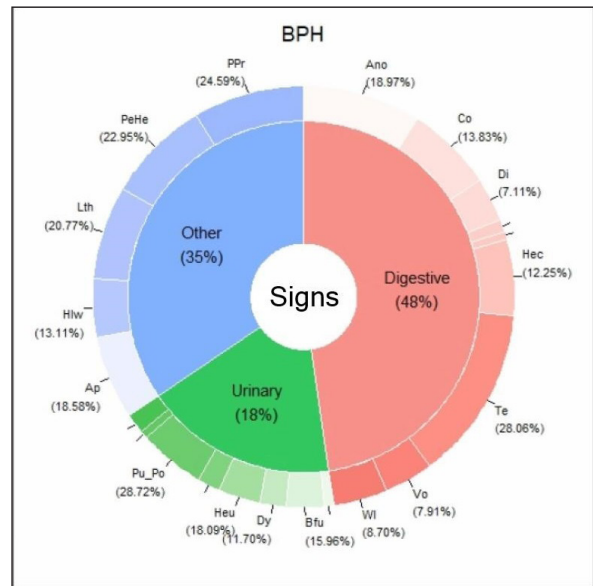


Fig. 1. Percentage of each sign (digestive, urinary, and others) affected and associated clinical signs for BPH. Clinical signs: Ano: anorexia; Co: constipation; Di: diarrhea; Hec: hematochezia; Te: tenesmus; Vo: vomiting; Wl: weight loss Bfu: blood dripping from the urethra; Dy: dysuria; Heu: hematuria; Pu_Po: polyuria/polydipsia; Ap: abdominal pain from palpation; Hlw: hind limb weakness; Lth: lethargy; PeHe: perineal hernia; and PPr: prostatomegaly or pain when rectal examination. The line without signs (-) indicates clinical signs that are not included because they appear in less than 5%.

prostatomegaly, pain during rectal examination, perineal hernia, and lethargy being the clinical signs that occurred most frequently. Of the urinary signs, polyuria/polydipsia was the most frequent, followed by hematuria and blood dripping from the urethra.

In the case of prostatitis (Fig. 2), the frequency of signs categories was similar (digestive signs, other signs, and urinary signs, respectively), but there were variations in the prevalence within each category. Of the digestive signs, anorexia became the most frequent, followed by tenesmus and weight loss. Lethargy and abdominal pain from palpation were the most frequently seen in the category of “other signs,” followed by prostatomegaly or pain during the rectal examination.

In the case of PN (Fig. 3), weight loss and anorexia were the most frequent digestive signs observed. Nearly half of the “other signs” category consisted of lethargy, followed in similar proportions by perineal hernia, abdominal pain from palpation, hind limb weakness, and prostatomegaly or pain during the rectal examination. Urinary signs constituted a lower percentage, with only polyuria/polydipsia and dysuria signs observed.

Main associated clinical signs

The ORs for prostatic disorders adjusted for clinical associations such as digestive, urinary, and “other

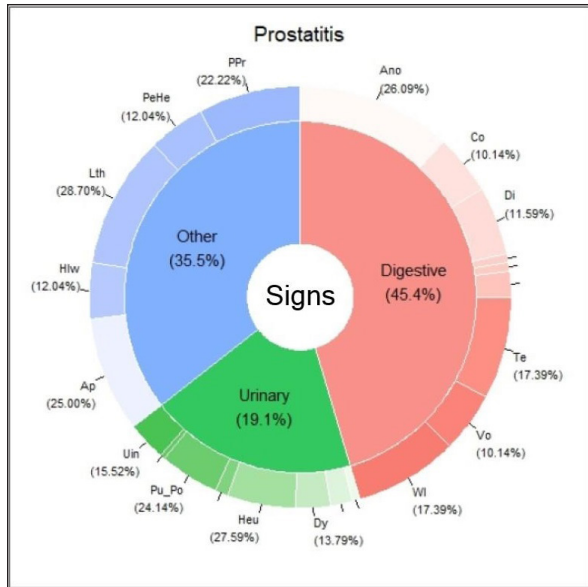


Fig. 2. Percentage of each sign (digestive, urinary, and others) affected and associated clinical signs for prostatitis. Clinical signs: Ano: anorexia; Co: constipation; Di: diarrhea; Te: tenesmus; Vo: vomiting; Wl: weight loss; Dy: dysuria; Heu: hematuria; Pu_Po: polyuria/polydipsia; Uin: Urinary incontinence; Ap: abdominal pain from palpation; Hlw: hind limb weakness; Lth: lethargy; PeHe: perineal hernia; and PPr: prostatomegaly or pain during rectal examination. The line without signs (-) indicates clinical signs that are not included because they appear in less than 5%.

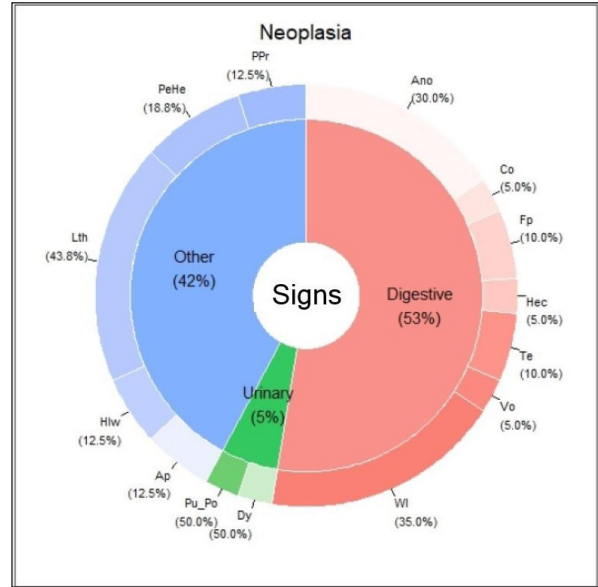


Fig. 3. Percentage of each sign (digestive, urinary, and other) affected and associated clinical signs for the PN. Clinical signs: Ano: anorexia; Co: constipation; Fp: flat stools; Hec: hematochezia; Te: tenesmus; Vo: vomiting; Wl: weight loss; Dy: dysuria; Pu_Po: polyuria/polydipsia; Ap: abdominal pain from palpation; Hlw: hind limb weakness; Lth: lethargy; PeHe: perineal hernia; and PPr: prostatomegaly or pain during rectal examination.

Table 3. OR, CI (95% CI), and significance (*p*-value) of digestive signs in BPH, prostatitis, and PN.

Variable	Benign prostatic hyperplasia			Prostatitis			Prostatic neoplasia		
	OR	95% CI	<i>p</i> -value	OR	95% CI	<i>p</i> -value	OR	95% CI	<i>p</i> -value
Tenesmus	1.50	0.80, 2.90	0.2	0.95	0.49, 1.78	0.9	0.16	0.01, 0.99	0.088
Anorexia	0.39	0.20, 0.75	0.005	2.07	1.06, 4.05	0.033	2.28	0.44, 13.9	0.3
Weight loss	0.27	0.13, 0.55	<0.001	2.27	1.08, 4.68	0.027	20.2	3.27, 157	0.002
Constipation	0.82	0.38, 1.83	0.6	1.50	0.67, 3.22	0.3	0.56	0.03, 4.47	0.6
Hematochezia	2.87	1.11, 8.58	0.041	0.39	0.13, 1.02	0.073	0.79	0.04, 5.92	0.8
Vomiting	1.09	0.45, 2.78	0.9	1.32	0.53, 3.11	0.5	0.19	0.01, 1.54	0.2
Diarrhea	0.33	0.13, 0.82	0.017	3.39	1.39, 8.29	0.007	NPS	NPS	NPS
Dyschezia	1.88	0.21, 45.0	0.6	0.62	0.03, 5.12	0.7	NPS	NPS	NPS
Flat stools	0.19	0.03, 1.22	0.084	1.53	0.19, 9.21	0.7	13.7	1.96, 142	0.008

CI = confidence interval; NPS: no presence of clinical signs; OR = odds ratio. *p*-value in bold: significant odds ratio values (*p* < 0.05).

signs” are presented in Tables 3–5, respectively. After adjusting for associated digestive signs (Table 3), we noticed that the OR for anorexia (*p* = 0.033), weight loss (*p* = 0.027), and diarrhea (*p* = 0.007) were very high for prostatitis. The OR for hematochezia (*p* = 0.041) increased only for BPH. In the case of PN, the main clinical signs were strongly associated with flat

stools (*p* = 0.008) and weight loss (*p* = 0.002). Patients with PN did not present clinical signs of diarrhea and dyschezia.

A similar pattern can be described for urinary signs (Table 4), where the OR of hematuria (*p* = 0.004) and urinary incontinence (*p* = 0.043) were strongly associated with prostatitis. In the rest of the prostatic

Table 4. OR, CI (95% CI), and significance (*p*-value) of urinary signs in BPH, prostatitis, and PN.

Variable	Benign prostatic hyperplasia			Prostatitis			Prostatic neoplasia		
	OR	95% CI	<i>p</i> -value	OR	95% CI	<i>p</i> -value	OR	95% CI	<i>p</i> -value
Hematuria	0.44	0.20, 0.98	0.041	3.25	1.45, 7.24	0.004	NPS	NPS	NPS
Blood dripping from the urethra	0.91	0.36, 2.53	0.8	0.86	0.26, 2.38	0.8	NPS	NPS	NPS
Pollakiuria	1.06	0.27, 5.07	>0.9	0.72	0.12, 3.25	0.7	NPS	NPS	NPS
Stranguria	1.10	0.10, 27.2	>0.9	1.55	0.06, 18.4	0.7	NPS	NPS	NPS
Dysuria	0.46	0.18, 1.22	0.11	2.32	0.83, 6.18	0.10	1.72	0.09, 10.1	0.6
Anuria	0.56	0.10, 4.10	0.5	2.51	0.34, 13.5	0.3	NPS	NPS	NPS
Urinary incontinence	0.33	0.12, 0.93	0.036	2.96	1.01, 8.54	0.043	NPS	NPS	NPS
Polyuria/polydipsia	0.57	0.28, 1.17	0.12	1.94	0.91, 4.02	0.079	0.71	0.04, 4.01	0.7

CI = confidence interval; NPS = no presence of clinical signs; OR = odds ratio. *p*-value in bold: significant odds ratio values ($p < 0.05$)

Table 5. OR, CI (95% CI), and significance (*p*-value) of other signs in BPH, prostatitis, and PN.

Variable	Benign prostatic hyperplasia			Prostatitis			Prostatic neoplasia		
	OR	95% CI	<i>p</i> -value	OR	95% CI	<i>p</i> -value	OR	95% CI	<i>p</i> -value
Hind limb weakness	0.65	0.30, 1.41	0.3	1.64	0.73, 3.57	0.2	1.60	0.22, 7.59	0.6
Perineal hernia	1.02	0.51, 2.11	>0.9	0.90	0.41, 1.87	0.8	3.15	0.59, 14.6	0.15
Abdominal pain from palpation	0.41	0.22, 0.77	0.005	2.83	1.49, 5.35	0.001	0.55	0.08, 2.54	0.5
Prostatomegaly or pain when rectal examination	0.53	0.29, 0.99	0.044	2.07	1.09, 3.92	0.025	0.71	0.10, 3.39	0.7
Lethargy	0.28	0.15, 0.50	<0.001	2.70	1.46, 5.00	0.001	12.7	2.82, 90.5	0.003

CI = confidence interval; OR = odds ratio. *p*-value in bold: significant odds ratio values ($p < 0.05$)

disorders, no tendency towards any particular sign was displayed. Patients with PN did not present urinary signs such as hematuria, blood dripping from the urethra, pollakiuria, stranguria, anuria, or urinary incontinence.

Finally, regarding “other signs” category (Table 5), we observed that the OR was almost three times higher for abdominal pain from palpation ($p = 0.001$) and lethargy ($p = 0.001$), and two times higher for prostatomegaly or pain during rectal examination ($p = 0.025$) for prostatitis. In the case of PN, only lethargy ($p = 0.003$) seemed to be relevant and was strongly associated with this prostatic disorder.

Discussion

This study is the first to show that there are clinical signs with a greater degree of association for certain prostatic disorders in canines. Although several clinical signs are common and overlap in different prostatic disorders, signs such as diarrhea, anorexia, weight loss, hematuria, and urinary incontinence have been shown to have a higher ORs for prostatitis than for animals with BPH. However, hematochezia had a higher

predictive value for BPH, not being a significant sign in cases of prostatitis. On the other hand, weight loss and lethargy were clinical signs strongly associated with PN. Thus, this study contributes from another perspective to the one provided by Polisca *et al.* (2016), who compared the frequency of clinical signs observed in prostatic disorders. Furthermore, unlike the report by Polisca *et al.* (2016), our study shows that even within each group of signs (digestive, urinary, or systemic), some of them are more associated with a prostatic disorder than others. For example, within digestive signs, diarrhea was largely associated with prostatitis, while hematochezia was more strongly associated with BPH. Therefore, our study shows that there are specific signs (and not necessarily a group of clinical signs) that are greatly associated with certain prostatic disorders in canines. In addition, this 9-year retrospective study on prostatic disorders in canines conducted in Latin America (Uruguay), expands the information available from other epidemiological studies conducted in other regions of the world (Krawiec and Heflin, 1992; Polisca *et al.*, 2016). Briefly, in our country, BPH was the canine prostatic disorder most frequently diagnosed, followed

by prostatitis and, less frequently, PN, PCs, and SM. Besides, prostatic diseases occurred in large, non-castrated canines, with a mean age of 10 years, which agrees with what was reported in the bibliography (Smith, 2008; Foster, 2012; Polisca *et al.*, 2016; Cunto *et al.*, 2019).

Our main objective was to evaluate the clinical relevance of the main clinical signs associated with the different prostatic disorders in canines who were admitted to the hospital of the FVET–UdelaR between 2011 and 2019. Based on the results of this study, we were able to confirm our hypothesis. From the analysis of the clinical signs and their association with the different canine prostatic disorders, we were able to observe that our results could contribute to the differentiation of prostatic disorders. Thus, urinary signs (hematuria and urinary incontinence) were strongly associated with prostatitis. Animals with suspected prostatic diseases and hematuria were three times more likely to present with prostatitis than any other prostatic disease. In turn, the OR for urinary incontinence was almost three times greater for prostatitis than for any other prostatic disorder. It is possible that urinary signs are more frequently observed in prostatitis because it often shares infection with the bladder and urethra (Lévy *et al.*, 2014). In addition, if prostatitis becomes chronic, recurrent clinical signs of cystitis and urinary tract inflammation may be the only signs observed in the patient (Barsanti and Finco, 1986). Within the digestive signs, tenesmus was one of the most frequently observed clinical signs in prostatic diseases, not being associated with any particular prostatic disorder. This is to be expected due to the anatomical position of the prostate, located ventrally to the colon (Kutzler and Yeager, 2005; Smith, 2008), and because all prostatic disorders present with prostatomegaly causing the colonic lumen to decrease in size due to pressure from the diseased prostate gland (Christensen, 2018). The effort to defecate could cause small lacerations at the level of the anal sphincter and cause the appearance of hematochezia. This could explain why, in our study, hematochezia could only be associated with BPH, being almost three times more likely to be seen in canines with BPH suspected of prostatic disorder. Although anorexia was associated with both BPH and prostatitis, the association was much stronger for the latter. The OR that a canine with anorexia and suspected of having prostatic diseases had prostatitis was two times higher than that of having any other prostatic disorder. Anorexia could be explained by lethargy, another sign also associated with the main prostatic disorders (BPH, prostatitis, and neoplasia), but more strongly associated with prostatitis. Another possible explanation for anorexia in animals with prostatitis could be the strong pain caused by the gland's inflammation, described in this work as abdominal pain from palpation, making it almost three times more likely that a patient with pain

and suspicion of prostatic diseases had prostatitis. All clinical signs of prostatitis found coincided with what had previously been reported in other studies (Barsanti and Finco, 1986; Smith, 2008; Lévy *et al.*, 2014). Weight loss and lethargy were clinical signs observed with high frequency and were highly associated with PN, although to a lesser extent, it was also associated with prostatitis. In this sense, canines suspected of having a prostate disease that presents weight loss are 20 times more likely to be suffering from PN versus prostatitis, and 12 times more likely that the canine has PN versus prostatitis if you have lethargy. These results could be expected due to the systemic effects produced by the PN and how advanced it usually is at the time of diagnosis. PN often presents regional and/or distant metastases at the time of consultation, causing a lot of pain and multi-organ failure (Teske, 2009; Lévy *et al.*, 2014). In summary, prostatitis and PN were the disorders to which some signs could be more strongly associated. Prostatitis was characterized by a greater number of clinical signs related to inflammation and pain, and a greater systemic repercussion in the animal. PN presented an increase in clinical signs that were related to digestive and other processes linked to general systemic repercussions to the detriment of urinary signs. The information obtained in this study may be useful for the veterinarian, contributing to the presumptive diagnosis of canine prostatic disease based on the association of clinical signs that patients present, once a prostatic disorder is presumed based on the support of the B-mode ultrasonographic study. This will allow the veterinarian to prioritize the choice of the best complementary diagnostic method that will contribute to obtaining a definitive diagnosis.

Our secondary objective was to describe the prevalence of prostatic disorders, age, body size, and reproductive status of the canine population under study. This study was carried out with canines that attended the veterinary clinic with a prostatic disorder and clinical signs compatible with it. Only a small proportion of the canines in this study were asymptomatic, which were considered to have some prostatic disorder based on B-mode ultrasonography imaging consistent with an enlarged prostate and echostructure consistent with prostatic disorder (Cunto *et al.*, 2019; Mattoon and Davidson, 2020) and is reported in the results. Some canines are known to have BPH and are asymptomatic (Christensen, 2018; Cunto *et al.*, 2022) until prostatic enlargement is sufficient to produce clinical signs (Smith, 2008). For this reason, we must be cautious since it is likely that patients with asymptomatic prostatic disorders are older, since dogs rarely come to the FVET–UdelaR hospital for prostate control without clinical signs compatible with prostatic disorder. The population of canines with prostate disease in our study was mostly represented by medium-sized and large-size canines, non-castrated and with a mean age that far exceeds that reported in the bibliography

(Polisca *et al.*, 2016; Cunto *et al.*, 2022). The prostatic disorder that occurred most frequently was BPH, followed by prostatitis, which coincides with what has already been reported internationally (Johnston *et al.*, 2001; Smith, 2008; Foster, 2012; Polisca *et al.*, 2016; Cunto *et al.*, 2019). In our work, BPH represented 71.6% of the prostatic disorders studied, similar to the 63% mentioned by Foster (2012), but higher than the 45.9% reported by Polisca *et al.* (2016). The difference in the proportion of presentation of BPH of our work with those of the bibliography could be related to the way of diagnosis of prostatic disorders. In many veterinary care centers around the world, diagnoses of prostatic disorder are presumptive and based on anamnesis, clinical signs, and ultrasonographic studies (Zambelli *et al.*, 2012). This situation is similar to what happens in the hospital of the FVET–UdelaR. In a study with similar characteristics to ours, Polisca *et al.* (2016) reported similar difficulties, where more than 50% of the cases lacked a definitive diagnosis. The second most frequent prostatic disorder after BPH was prostatitis, with 23.5%, coinciding with what has been reported internationally (Johnston *et al.*, 2001; Smith, 2008; Foster, 2012; Polisca *et al.*, 2016; Cunto *et al.*, 2019). It is known that BPH is the underlying cause of some prostatic disorders, such as prostatitis, caused by bacterial contamination of the fluid from cystic structures (Hecht, 2008; DiBartola and Westropp, 2019). As we mentioned above, since most of the cases included in this study, as in many other international reports, do not have a definitive diagnosis, we could be overestimating the occurrence of BPH in the hospital of FVET–UdelaR. Part of the population with BPH could be patients with prostatitis with similar clinical signs and with subtle ultrasound changes that did not allow differentiation between the two disorders. In this same sense, chronic prostatitis can be asymptomatic and/or present nonspecific ultrasound changes (Hecht, 2008; Cunto *et al.*, 2019; Palmieri *et al.*, 2022). For all these reasons, it is relevant to reach a definitive diagnosis, which will allow establishing an adequate treatment and avoiding recurrences. Although the definitive diagnosis can be reached by means of a biopsy for histopathology (Palmieri *et al.*, 2022), it is not usually recommended (Cunto *et al.*, 2022). Another less invasive technique that can be used is ultrasound-guided fine needle aspiration. High diagnostic value of prostatic disorders has been reported when fine needle cytology is combined with ultrasound evaluation of the prostate (Rodak *et al.*, 2018). On the other hand, the culture of prostatic fluid or urine, obtained by ultrasound-guided aseptic puncture, could be a useful, less expensive, and less invasive tool to differentiate BPH from prostatitis (Lévy *et al.*, 2014; Das *et al.*, 2017). Some authors mention that in some cases, ultrasound-guided fine-needle aspiration is contraindicated, such as in the presence of prostatic

abscess (Smith, 2008) and PN (Christensen, 2018), due to the possibility of seeding bacteria with the needle and neoplastic cells, respectively. In the countries where it is available, the serum determination of canine prostatic specific esterase (CPSE) could be a useful and less invasive tool as a complement to the diagnosis of prostatic disorders. Significantly elevated serum CPSE concentrations have been found in BPH canines compared to normal dogs (Wolf *et al.*, 2012; Holst *et al.*, 2017; Pinheiro *et al.*, 2017; Dearakhshandeh *et al.*, 2020). Therefore, CPSE is a valuable biomarker, and its use has been suggested in the diagnosis of dogs with clinical signs of BPH, follow-up treatment of prostatic diseases, and routine check-ups in geriatric patients (Holst *et al.*, 2017; Pinheiro *et al.*, 2017). In this sense, the correct diagnosis of prostate disease is a challenge. Submit canines older than 6 or 7 years to prostatic B-mode ultrasonography, as suggested by Polisca *et al.* (2016); adding the serum determination of CPSE could serve as screening to detect asymptomatic canines with prostatic disorders early.

In conclusion, this study shows that there are clinical signs with a higher degree of association for certain canine prostatic disorders than others, as evidenced by the higher predictive value presented by diarrhea, anorexia, weight loss, hematuria, and urinary incontinence for prostatitis compared with BPH. In addition, this 9-year retrospective study on prostatic disorders in canines conducted in Latin America (Uruguay) expands and complements the information available from other epidemiological studies conducted in other regions of the world.

Acknowledgments

To the administrative staff of the hospital of the FVET–UdelaR, especially to Francisco, for his great help in the search and selection of clinical records. To Emiliano D’Anatro for his collaboration in reviewing the clinical records.

Conflict of interest

The authors declare that there is no conflict of interest.

Author contributions

Dr. Guillermo Cazzuli: research design, acquisition, analysis, and interpretation of data, drafting the paper. Dr. Gonzalo Suárez: analysis and interpretation of data, critical review of the manuscript. Dra. Stefania Busconi: acquisition of data. Dr. Juan Pablo Damian: analysis and interpretation of data, drafting the paper, critical review of the manuscript. Dra. Paula Pessina: research design, interpretation of data, critical review of the manuscript.

Funding

This research received no specific grant.

Data availability

The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request.

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