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Contributing Factors and Management of Pyometra in Dogs of Algeria

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ABSTRACT

Pyometra is one of the most frequent and complex reproductive pathologies in older intact bitches over eight years of age, characterized by the accumulation of purulent material within the uterus. The present study aimed to analyze the influence of predisposing factors, including age, breed, parity, and estrous cycle, on the development of pyometra and evaluate diagnostic and therapeutic approaches. Seventeen cases were recorded at the Institute of Veterinary Sciences, University of Tiaret, Algeria, from September 2021 to September 2023. Among these cases, 47.05% (n = 8) involved bitches aged from two to four years, representing the most affected age group. German Shepherds accounted for 23.52% (n = 4) of cases, followed by Rottweilers and Pitbulls with 17.64% (n = 3) each. Nulliparous bitches represented 70.59% (n = 12) of the affected dogs, indicating a higher susceptibility compared to multiparous bitches. In 35.29% (n = 6) of cases, pyometra developed approximately eight weeks after the end of the previous estrous cycle. Ultrasonography proved to be a reliable and efficient tool for diagnosing both open- and closed-cervix pyometra in bitches. Ciprofloxacin and amoxicillin with clavulanic acid were effective medicines in selected cases, while ovariohysterectomy remained the definitive therapeutic approach. Overall, the study demonstrated that young, nulliparous bitches were more susceptible to pyometra, and that both medical and surgical treatments were effective, with no recurrence observed during follow-up.

Keywords: Bitch, Nulliparous, Ovariohysterectomy, Pyometra, Ultrasound

INTRODUCTION

Dogs are widely regarded as loyal companions and hold a significant place in many households. However, lifestyle changes have been associated with an increased prevalence of both general and reproductive health disorders. Pyometra remains the most prevalent condition in intact bitches followed by dystocia and transmissible venereal tumors as the most common reproductive disorders in intact bitches (Verma et al., 2022). Pyometra is defined as a uterine disorder in intact bitches characterized by the accumulation of purulent material within the uterine lumen, resulting from bacterial infection and prolonged progesterone influence during the luteal phase. The condition is commonly associated with opportunistic bacteria ascending from the vaginal flora, primarily *Escherichia coli*, but also *Staphylococcus* spp., *Streptococcus* spp., and *Proteus* spp. (Hagman, 2018; Xavier et al., 2023). Pyometra is classified into two types, including open and closed, depending on the presence or absence of vulvar discharge (Smith, 2006). Pyometra can occur at any time after the first estrus and affects younger bitches, with an average age of two years (Melandri et al., 2019).

Risk factors have occasionally been reported within certain breeds, increasing the likelihood of developing pyometra (Jitpean et al., 2012; Verma et al., 2022) found that the occurrence of pyometra was more common in Labradors, with an incidence rate of 37.70%, German Shepherds had an incidence of 13.10%, followed by unspecified breeds at 9.84%. On the other hand, Sethi et al. (2020) reported the highest occurrence of pyometra in unspecified breeds at 29.63%, followed by Labradors at 24.07% and Pugs at 15.74%. In contrast, German Shepherds, Rottweilers, Saint Bernards, and Pomeranians exhibited lower rates, at 5.56%, 3.7%, 3.7%, and 3.7%, respectively. Different treatment protocols have been employed to manage pyometra in dogs, including antibiotic therapy alone (Threlfall, 1995) as well as the use of prostaglandins (Gobello et al., 2003), aglepristone (Fieni et al., 2014), and cloprostenol (Khan et al., 2007). However, ovariohysterectomy remains the most widely recommended treatment option for pyometra (Dabrowski and Wawron, 2014). No studies have been published regarding the incidence and causes of canine pyometra in Algeria. The present study aimed to explore the incidence of pyometra in dogs, along with the predisposing factors, including age, parity, breed, and the diagnostic and treatment approaches.

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MATERIALS AND METHODS

Ethical approval

The study received ethical approval from the Institute of Veterinary Sciences Ethics Committee in Tiaret, Algeria. All procedures adhered to established guidelines for animal research. Additionally, consent was obtained from all pet owners prior to conducting any experiments and scientific procedures.

Study population and grouping criteria

The present study included seventeen female dogs managed at the Domestic Carnivore Clinic of the Institute of Veterinary Sciences in Tiaret, Algeria, from September 2021 to September 2023. These bitches, aged from seven months up to 11 years and weighing among six up to 45 kg, presented with signs of lethargy, anorexia, weight loss, vomiting, polyuria-polydipsia (PUPD), and vulvar discharge. Diagnosis was established based on the clinical manifestations, vaginal smear analysis, and findings from medical imaging, particularly ultrasound. Upon admission, all bitches underwent a comprehensive clinical examination. The reproductive history of each individual was recorded, alongside all observed clinical signs. These dogs, all owned by private individuals, were exclusively purebred, with the following breed distribution including three Rottweilers, three American Pit Bull Terriers, four German Shepherds, one English Pointer, two Arabian Greyhounds, one American Staffordshire Terrier, one Bichon, one Pekingese, and one Argentinian Mastiff. The dogs were grouped based on age and breed. The age distribution included 0 (from puberty) to 1 year, 2-4 years, 5-7 years, 8-9 years, and over 10 years. All seventeen bitches were confirmed to have pyometra based on clinical presentation and diagnostic evaluations performed at the Domestic Carnivore Clinic, Institute of Veterinary Sciences, Tiaret, Algeria.

Diagnostic procedures

Vaginal cytology

Vaginal samples were obtained with a sterile cotton-tipped applicator inserted into the vaginal canal, ensuring minimal risk of contamination from the clitoral fossa. The vaginal swabs were carefully rolled onto clean glass slides to prepare smears. These smears were allowed to air-dry and then stained using the KIT RAL555, which is defined as a rapid-acting variant of the May-Grünwald-Giemsa stain, following the manufacturer's instructions (CellaVision, Sweden). The stained slides were observed under an Optika B-350 light microscope (Optika, Italy) at 40× magnification to evaluate the cellular composition, including neutrophils, epithelial cells, and bacteria. Gram-positive and Gram-negative bacteria were identified, with the specific types categorized based on their staining characteristics. Cytologically, pyometra samples typically show fewer endometrial epithelial cells, often with degenerative changes. There is also a predominance of non-degenerate and degenerate neutrophils and an increased presence of lymphocytes, macrophages, and plasma cells. Intracellular and free bacteria are abundant, which play a significant role in identifying and diagnosing infection (Solano-Gallego and Masserdotti, 2016). The cytological findings were categorized into different stages of the estrous cycle or infection status, as detailed in established veterinary references for female dogs. These stages include proestrus, estrus, metestrus, and anestrus, each defined by particular cellular compositions that aid in evaluating the animal's reproductive or infectious condition (Johnston et al., 2001; Feldman and Nelson, 2004).

Ultrasonography

Uterine enlargement and content were assessed and measured by ultrasound using an ImaGO.S 5 MHz multi-frequency convex probe (IMV Technologies, France). All the bitches were placed in either lateral or dorsal recumbency and gently restrained without the use of sedation to minimize stress during the procedure.

Treatment protocol

The therapeutic protocol used in the present study was based on the guidelines of Threlfall (1995) for the medical management of pyometra, which primarily involves the use of antibiotics and supportive treatment care. The treatment protocol for bitches with pyometra included a 14-day course of antibiotic therapy and supportive care, in accordance with established veterinary guidelines. The antibiotic treatment consisted of ciprofloxacin (CIPROLON®, Hikma Pharmaceuticals, Jordan), 500 mg tablets, administered orally at a dose of 5 to 10 mg/kg, twice daily for 14 days (Plumb, 2021). Amoxicillin with clavulanic acid (AUGMENTIN®, GlaxoSmithKline, UK), 500 mg tablets, administered orally at a dose of 10 to 20 mg/kg, twice daily for 14 days (Plumb, 2021). The supportive care regimen included injectable ciprofloxacin (CIPROFLOXACINE RAZES®, Laboratoires RAZES, Algeria), a human-use solution, administered intravenously at a dose of 10 to 20 mg/kg (Plumb, 2021). Injectable amoxicillin (AMOXI-LH 15%®, Livisto, Germany), a veterinary suspension (150 mg/ml), was administered intramuscularly at a dose of 10 to 20 mg/kg (Plumb, 2021).

Injectable dexamethasone (Azium®, MSD, USA), a veterinary solution, was administered intravenously at a dose of 0.1 mg/kg on days 0 (day of consultation when treatment was initiated), 1, 2, and 3 (Plumb, 2021). Intravenous saline and glucose infusions were provided to maintain hydration and support metabolism (Plumb, 2021). These antibiotics (CIPROLON®, AUGMENTIN®, and CIPROFLOXACINE RAZES®) were initially intended for human use but were employed due to the unavailability of equivalent veterinary formulations in Algeria. The dosages were carefully adjusted to meet the physiological needs of the bitches.

Eleven bitches (Rottweiler, Pitbull, German Shepherd, English Pointer, American Staffordshire Terrier, Arabic Greyhound, and Argentine Dog) were treated with antibiotics for pyometra. Within 24 hours, all began to eliminate the purulent contents of the uterus. Ultrasound imaging demonstrated a reduction in hypoechoic and anechoic areas. Treatment was stopped after 15 days for nine bitches, while the remaining three continued therapy for 21 days.

Clinical monitoring

Clinical examinations and uterine ultrasounds were performed on days 0, 7, and 14. If anechogenic areas persisted on day 14, an additional ultrasound was conducted on day 21. In cases where pyometra persisted beyond day 14, treatment continued until day 21. Dogs with closed-cervix pyometra underwent ovariohysterectomy immediately, without further treatment. For cases where the treatment proved ineffective, meaning no significant improvement in clinical signs or ultrasound findings, ovariohysterectomy was also performed. The bitches were closely monitored through a questionnaire sent to their owners. The questionnaire aimed to assess the onset of subsequent estrus, the occurrence of pregnancy, and any recurrence of pyometra over the following six months.

Statistical analysis

All data were recorded in Excel 2016 Office (Microsoft, USA) files, and mean standard deviation (SD) values were calculated for continuous variables such as age (4.3 ± 3.5 years). Statistical tests were applied to evaluate the following parameters, including age at diagnosis, breed distribution, parity, mating history, estrus phase, and signs. ANOVA was used for continuous variables, such as age, to compare group differences. In ANOVA, the F-test was used to calculate the p-value by assessing the variance among groups against the variance within groups. Categorical variables, including parity, breed, mating history, estrus phase, and signs, were analyzed using chi-square or Fisher's exact tests to identify associations. Results were considered statistically significant at $p \leq 0.05$. Statistical analysis was performed using the online tool Vassar Stats, a website for statistical computation.

RESULTS AND DISCUSSION

Association of age with pyometra

The incidence rates of pyometra across different age groups in dogs are presented in Table 1. In the present study, the highest percentage of affected dogs was found in the two-to-four-year age group, with a mean onset of 4.3 ± 3.5 years (ranging from seven months to 11 years). A p-value of ≤ 0.05 suggested statistically significant differences in the age at diagnosis among the age groups. The current results indicated that pyometra primarily did not impact older dogs, since the average age at diagnosis (4.3 ± 3.5 years) was younger than what has been previously documented in the literature. Melandri et al. (2019) suggested that pyometra did not primarily affect older bitches, with a mean age at diagnosis of 5.14 ± 1.75 years. Similarly, Baithalu et al. (2010) found that pyometra could occur any time after the first estrus but predominantly affected younger animals, with a mean age of two years. In contrast, Hagman (2018) reported a mean age of seven years, and Sethi et al. (2020) observed a mean age of 5.65 ± 0.3 years. The current findings indicated that in this study sample, pyometra impacted younger dogs than the ages usually cited in the literature.

Table 1. Incidence rates of pyometra in different age groups of female dogs diagnosed at the Domestic Carnivore Clinic, Algeria, from September 2021 to September 2023

Serial number	Age group	Number of pyometra cases	Association of age with pyometra (%)
1	0-1 year	3	17.64
2	2-4 years	8	47.05
3	5-7 years	2	11.76
4	8-9 years	3	17.64
5	> 10 years	1	5.88
Total	--	17	100

Mean age at diagnosis: 4.3 ± 3.5 years.

Incidence of pyometra in correlation with estrus

The incidence of pyometra was highest eight weeks after the last estrus, reaching 35.29 percent ($p > 0.05$; Table 2) suggesting that the observed variations in the distribution of pyometra cases throughout the time intervals (weeks post-estrus) lacked statistical significance. This peak incidence occurred during the diestrus phase of the estrous cycle. However, at the time of consultation, 64.70 percent of the bitches were in the diestrus phase, while 35.29 percent were in anestrus. According to Baithalu et al. (2010), pyometra can develop at any stage of the estrous cycle or during pregnancy.

Table 2. The onset of pyometra in relation to estrus in female dogs diagnosed at the domestic carnivore clinic, Institute of Veterinary Sciences, Tiaret, Algeria, from September 2021 to September 2023

Weeks post-estrus	Number of cases	Incidence of pyometra in correlation with estrus (%)
≤ 2 weeks	3	17.64
> 2-4 weeks	3	17.64
> 4-8 weeks	5	29.41
> 8 weeks	6	35.29
total	17	100

The findings of post-estrus conditions in a column suggest no statistically significant difference ($p > 0.05$)

Incidence based on breed

Analysis of the incidence of pyometra by breed of dogs revealed that the highest incidence was observed in the German Shepherd, accounting for 23.52 percent (Table 3). This was followed by the Rottweiler and Pit Bull breeds, each with an incidence rate of 17.64 percent (Table 3). The results of the present study differed from those of Martins et al. (2015) and Sethi et al. (2020), who found a higher incidence of pyometra in mixed or undescribed breeds.

Conversely, Verma et al. (2022) found that the highest incidence ($p > 0.05$) of pyometra occurred in Labradors, with a rate of 37.70 percent, followed by German Shepherds at 13.10 percent. According to Verma et al. (2022), these variations might be attributed to regional differences in dog breed preferences among owners in different geographical areas, which confirmed the findings of the statistical analysis conducted in the present study. There is no statistically significant relationship between breed and the incidence of pyometra ($p > 0.05$).

Table 3. Incidence of pyometra for different dog breeds, aged from seven months to 11 years, and weighing from six to 45 kg, diagnosed at the Domestic Carnivore Clinic, Institute of Veterinary Sciences, Tiaret, Algeria, from September 2021 to September 2023

Breeds	Number of cases	Incidence of pyometra based on breed (%)
Rottweiler	3	17.64
American pit bull terrier	3	17.64
German shepherd	4	23.56
Pointer English	1	5.88
Arabic greyhound	2	11.76
American Staffordshire terrier	1	5.88
Bichon	1	5.88
Pekingese	1	5.88
Argentinian mastiff	1	5.88
Total	17	100

The current findings suggest no statistically significant difference ($p > 0.05$)

Mating history and parity in dogs

The incidence of pyometra was significantly higher ($p > 0.05$) in bitches that had not mated before the onset of pyometra, accounting for 52.94 percent of cases (Table 4), followed by 47,06 percent of cases in bitches that had mated before the onset of pyometra. Sethi et al. (2020) indicated that the highest number of pyometra cases (53.41%) occurred in dogs that had not mated, followed by 28.41% in dogs where mating occurred, but the female did not conceive. This relationship between the history of mating and the occurrence of pyometra was not statistically significant ($p = 1.0$), indicating that the history of mating did not influence the occurrence of pyometra in the current study.

In the present study, 70.59 percent of the bitches were nulliparous, while only 29.41 percent were multiparous. The p-value ($p \leq 0.05$) indicated a statistically significant association between parity (nulliparous and multiparous) and the occurrence of pyometra. These findings suggested that nulliparous bitches were at a higher risk of developing pyometra

compared to multiparous bitches in the present study. A high incidence of pyometra in nulliparous bitches had also been reported by Sethi et al. (2020) and Verma et al. (2022). Additionally, Hagman (2023) observed that nulliparous bitches had a moderately increased risk ($p \leq 0.05$) of developing pyometra compared to multiparous or primiparous bitches.

The higher incidence in nulliparous bitches could be attributed to prolonged exposure to estrous cycles without hormonal interruption from pregnancy, which created conditions favorable for the development of pyometra (Hagman, 2018). Hormonal fluctuations, particularly elevated levels of progesterone during diestrus, could cause cystic endometrial hyperplasia (CEH), impairing uterine defenses and predisposing the uterus to bacterial infections (Smith, 2006; Hagman, 2018).

Dow (1959) first described the connection between CEH and pyometra, emphasizing the importance of repeated hormonal cycles in nulliparous bitches. Ververidis et al. (2010) further highlighted how persistent hormonal stimulation from estrous cycles created an environment conducive to infection, particularly in the absence of the uterine quiescence induced by pregnancy.

Table 4. History of mating in bitches diagnosed with pyometra at the Domestic Carnivore Clinic, Institute of Veterinary Sciences, Tiaret, Algeria, from September 2021 to September 2023

History of mating	Number of cases	Association of mating with pyometra (%)
No mating	9	52.94
Mating and whelping	5	29.41
Mating without conceiving	3	17.65
Total	17	100

Symptoms of pyometra in dogs

Out of the 17 bitches diagnosed with pyometra, 13 had open-neck pyometra and 4 had closed-neck pyometra. In the present study, all bitches with open-cervix pyometra (100%) had a foul-smelling purulent vulvar discharge, varying in consistency and color from yellow with bloodstains to brown. Vulvar discharge was observed exclusively in bitches with open-cervix pyometra, highlighting its significant association with pyometra ($p < 0.05$), that finding consistent with previous studies by Hagman (2018) and Xavier et al. (2023).

The most common signs observed in bitches with open neck pyometra were lethargy (53.83%), anorexia (46.15%), fever (38.46%), dehydration (30.76%), and polyuria (30.76%), followed by less common signs such as abdominal distension (23.07%), polydipsia (15.38%), and vomiting (7.69%; Table 5). These results aligned with the findings of Pretzer (2008), Jitpean et al. (2014), and Hagman (2018), who also reported lethargy, anorexia, polyuria, polydipsia, vomiting, and diarrhea as common clinical signs in pyometra cases. According to their research, the most frequent signs include inappetence (anorexia), lethargy, polydipsia, polyuria, tachycardia, and tachypnea, while fever, dehydration, vomiting, abdominal pain, and diarrhea are observed in approximately 15% to 30% of affected bitches. These signs were observed in both types of pyometra and did not show statistically significant differences ($p \geq 0.05$).

Table 5. Distribution of signs in bitches with open- and closed-cervix pyometra, aged from seven months to 11 years and weighing from six to 45 kg, diagnosed at the Domestic Carnivore Clinic, Institute of Veterinary Sciences, Tiaret, Algeria, from September 2021 to September 2023

Type of pyometra	Open neck		Closed neck	
Signs	**Number of cases**	**Percentage**	**Number of cases**	**Percentage**
Vulvar discharge	13	100	0	0
Lethargy	7	53.84	4	100
Anorexia	6	46.15	4	100
Vomiting	1	7.69	1	25
Abdominal distension	3	23.07	4	100
Dehydration	4	30.76	3	75
Hyperthermia	5	38.46	3	75
Hypothermia	0	0	1	25
Polyuria	4	30.76	4	100
Polydipsia	2	15.38	0	0

Some bitches (n = 5), in the early stages of open neck pyometra, exhibited no clinical signs other than vulvar discharge and appeared to be in stable general condition. This observation supported the notion that pyometra develops gradually and insidiously. According to Pretzer (2008), bitches with open-cervix pyometra are generally less

systemically ill than those with closed-cervix pyometra, and in the early stages of the disease, affected bitches might only show vulvar discharge without any other clinical signs.

On the other hand, clinical signs were more pronounced in the bitches with closed-neck pyometra. All four bitches (4-year-old Arabic Greyhound, 4-year-old Rottweiler, 9-year-old Bichon, and 10-year-old Pitbull) with closed neck pyometra demonstrated lethargy, anorexia, abdominal distension and severe dehydration. Vomiting was less common and was observed in only one bitch (4-year-old Rottweiler). Three bitches (4-year-old Arabic Greyhound, 4-years-old Rottweiler, and 9-year-old Bichon) were hyperthermic. While only one was severely hypothermic with a temperature of 35.9°C (Table 5). This result was consistent with data previously reported by Pretzer (2008), Baithalu et al. (2010), and Jitpean et al. (2017). Abdominal distension exhibited distinct patterns between bitches with open- and closed-cervix pyometra. It was present in all bitches with closed-cervix pyometra (100%), while it was significantly less common in those with open-cervix pyometra (23.07%). These findings highlighted abdominal distension as a crucial indicator of closed-cervix pyometra, revealing a statistically significant difference ($p < 0.05$).

Diagnosis of pyometra in dogs

The results of the ultrasound examination confirmed the presence of pyometra by revealing typical abnormalities in the uterus. In all cases, the uterine wall appeared irregular, the endometrium was hypertrophic, and the fluid content was slightly hypoechoic to anechoic. These findings were consistent with the findings of Bigliardi et al. (2004), Pretzer (2008), and Baithalu et al. (2010). According to Bigliardi et al. (2004), the hypoechoic to anechoic fluid content reflects the accumulation of purulent material within the uterine lumen, while the irregular uterine wall and hypertrophic endometrium indicate advanced stages of endometrial pathology associated with pyometra. Ultrasound is particularly useful in detecting intrauterine fluid, even when the uterine diameter appears normal, as noted by Hagman (2018). It also allows for the identification of other pathological changes in the uterine and ovarian tissues, such as ovarian cysts or endometrial hyperplasia, which could affect the success of medical treatment. Likewise, Bigliardi et al. (2004) and Suresh Kumar et al. (2023) highlighted ultrasound as a reliable and essential tool for detecting uterine abnormalities, reinforcing its role in the diagnosis and management of pyometra.

On vaginal cytological examination, parabasal cells and small intermediate cells were predominant. Neutrophil infiltration, along with degenerative cellular changes observed in the four bitches with closed-cervix pyometra and the eight bitches with open-cervix pyometra, indicated significant inflammatory changes in the uterine and endometrial tissues. Diagnosis by vaginal cytology remained a simple and effective method, which was in line with Baithalu et al. (2004). Vaginal cytology is a relevant method for assessing the increase in basophilic mononuclear cells (BMC). Hagman (2018) confirmed that vaginal cytology usually reveals significant leukocyte degeneration, accompanied by neutrophils as well as some macrophages, plasma cells, and lymphocytes, while bacterial phagocytosis was not consistently observed. Similarly, the present study revealed that parabasal cells were the predominant cell type identified in vaginal cytology examinations, accounting for 76.47 percent of cases. It is stated that no distinction has been made between the physiological parameters of the open and closed cervix in pyometra (Volpato et al., 2012; Vidya et al., 2020).

Treatment

Eleven bitches were selected for medical follow-up, including one Rottweiler, two Pitbulls, four German Shepherds, one English Pointer, one American Staffordshire Terrier, one Arabic Greyhound, and one Argentine Dog. Three bitches; a 4-year-old Arabic Greyhound, a 4-year-old Rottweiler, and a 9-year-old Bichon underwent ovariohysterectomy immediately, while three others died before treatment. Two of the deceased bitches, a 3-year-old Rottweiler and a 6-year-old Pekingese, died due to the advanced stage of the disease, presenting a poor prognosis. The third bitch, a 10-year-old Pitbull, was euthanized due to the presence of a carcinoma, in an advanced stage with severely deteriorated health. Ovariohysterectomy achieved a 100% success rate, with no mortality, no surgical site infections, and no haemorrhage, which stated that ovariohysterectomy was the preferred treatment option (Xavier et al., 2023). According to Hagman (2023), surgical treatment is the safest and most effective option, as it eliminates the source of infection and the bacterial products, thereby preventing the risk of recurrence.

Antibiotic medical treatment proved 100% effective, with all eleven bitches (Rottweiler, Pitbull, German Shepherd, English Pointer, American Staffordshire Terrier, Arabic Greyhound, and Argentine Dog) beginning to eliminate the purulent contents of the uterus within 24 hours of starting treatment. Ultrasound imaging showed an apparent reduction in hypoechoic and anechoic areas. The treatment was stopped after 15 days for nine bitches, while for the remaining three, it was continued for 21 days before being stopped.

Over a six-month observation period, the bitches were monitored for recurrence and return to heat. No cases of recurrence were recorded during this time. All bitches that received medical treatment successfully returned to heat

within four to six months after the cessation of the medical treatment, and two of the bitches that received treatment successfully whelped after completing their treatment.

CONCLUSION

Pyometra was more common in young bitches (4.3 ± 3.5 years) during the diestrus phase, with nulliparous bitches being significantly more predisposed to the development of this condition than multiparous bitches. The breeds with the highest incidence were German Shepherds, followed by Rottweilers and Pit Bulls. Ultrasound was a rapid and effective method for detecting pyometra, whether closed- or open-necked. Medical treatment with a combination of ciprofloxacin and amoxicillin with clavulanic acid was effective in the management of open-neck pyometra. Future studies in Algeria should focus on larger sample sizes and a more varied population of bitches to further validate the findings of the present study and examine additional factors that could influence the development and management of pyometra in the region.

DECLARATIONS

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Authors' contributions

Hammou Imane conducted the data collection, analysis, and writing of the manuscript. Khiati Baghdad and Slimani Khaled Mabrouk contributed to the clinical aspects of the study and provided the essential guidance throughout the project. All authors checked and approved the last edition of the article before submitting to the journal.

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Competing interests

The authors declared no competing interests related to this study.

Ethical considerations

All ethical considerations, including animal welfare and the use of clinical data, were ensured by the authors in accordance with institutional guidelines. There were no issues related to plagiarism, data fabrication, or misconduct.

Availability of data and materials

All data generated during this study are pertinent and included in the published article. For further information or inquiries, please contact the corresponding author.

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