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Prostate disorders in dogs, with a focus on benign prostatic hyperplasia (BPH): An overview

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Abstract
The prostate in male dogs is a bilobed gland with glandular and stromal components. It is an androgen-dependent organ, it surrounds the urethra, plays a crucial role in ejaculation. Prostatic fluid secretion is continuous, and its volume varies with prostate size. Prostatic anatomy evolves with age, with symptoms of prostatic diseases, such as prostatitis, prostatic cysts, abscesses, and neoplasia, becoming more common in intact males over six years. We attempted to condense significant prostatic affections in dogs in this review, paying particular attention to Benign Prostatic Hyperplasia (BPH). Understanding the canine prostate's clinical symptoms and anatomy is vital for accurate diagnosis. Prostatic diseases often present overlapping signs, complicating diagnosis. Various diagnostic tests, including physical exams, imaging, and fluid analysis, aid in precise diagnosis. Traditional and advanced treatments exist, with antibiotics, surgery, and castration being common approaches. Specific prostatic diseases, such as prostatitis, prostatic cysts, abscesses, and neoplasia, present distinct challenges. Acute prostatitis is associated with systemic symptoms, while chronic cases may lack overt signs. Prostatic cysts can be diagnosed via ultrasound, with treatment options including surgery and ultrasound-guided drainage. Prostatic abscessation results from chronic prostatitis and requires drainage, antibiotics, and castration. Prostatic neoplasia, though uncommon, poses diagnostic challenges, with treatment options limited and survival rates generally low. Benign Prostatic Hyperplasia (BPH) is a common age-related condition in intact males. Large breeds are more susceptible, with finasteride being a common medical therapy, effectively reducing prostatic size. Castration is the definitive treatment, causing a significant reduction in the prostate's size. Accurate diagnosis involves physical examinations, imaging, and fluid analysis. Prostatic radiography and ultrasonography aid in visualization, while prostatic fluid evaluation, massage, and biopsy provide valuable diagnostic information. Medicinal therapies, including finasteride and medroxyprogesterone acetate, aim to manage BPH symptoms. Surgical options, such as castration and subtotal prostatectomy, offer effective long-term solutions.

Keywords: Canine, male, neoplasia, prostatitis, prostatectomy

Introduction
The prostate is an ovoid-shaped, bilobed gland made of glandular and stromal elements in dogs. It is an androgen-dependent organ that surrounds the male dog's urethra from the neck of the bladder caudally. The first and third fractions of the ejaculate receive fluid from the prostate (Leis-Filho *et al.*, 2018) [30]. In healthy male dogs, the prostate secretes fluid continuously. Depending on the size of the prostate, the fluid can flow either antegrade out the external urethral or retrograde into the bladder in volumes ranging from a few drops to several milliliters. Position of prostate changes slowly with increase in size, being pelvic in young intact male dogs, it slowly becomes more abdominal and after 8-12 years becomes completely abdominal. Symptoms of canine prostatic disease are comparatively common in male dogs, particularly in intact males older than six years. A number of disease processes can affect the prostate gland in dogs, and these conditions frequently present with overlapping clinical signs that complicate diagnosis. Disorders of prostate are common in old and intact dogs, especially BPH, prostatitis, prostatic cyst, prostatic abscess and prostatic neoplasia, because of decrease in prostatic antibacterial factor after four years of age (Mantziaras *et al.*, 2017) [32].
Dog experiences very little discomfort at first, making clinical symptoms ephemeral and challenging to identify. Late presentation of case is responsible for poor prognosis, especially

associated to prostate cancer. It is found that benign prostatic hyperplasia develops due to a constant influence of the testosterone metabolite dihydrotestosterone on the glandular tissue, which causes proliferation and enlargement of glandular cells (Grino *et al.*, 1990) [20]. Usually, benign prostatic hyperplasia is uniform and diffuse in dogs. The expression of 5α-reductase in the prostate epithelium is higher in dogs so mainly epithelial hyperplasia is found. Prostatic anatomy and the clinical symptoms of canine prostatic disease must be thoroughly understood in order to make an accurate diagnosis of prostatic disease. Additionally, an accurate and quick diagnostic procedure is facilitated by understanding which diagnostic tests are necessary and how to perform them correctly. There are novel and advanced treatment modalities for dogs with prostatic disease in addition to conventional surgical and pharmaceutical approaches (Smith *et al.*, 2008) [38].

Prostatic gland anatomy

The prostate, the only accessory sex gland in male dogs, is a bilobate, fibromuscular organ that is typically located at the cranial aspect of the pelvic floor or just cranial to the pubic rim. The size of the gland, the degree of bladder fullness, and the breed, age, and body weight of the dog all affect where the prostate is located. The prostate is located ventral to the rectum and encircles the proximal part of the urethra. It ends close to the bladder's neck cranially (Fig. 1). The peritoneum envelops the dorsal and lateral aspects of the prostate, while the ventral aspect is covered by periprostatic fat and lies outside of it (Leis-Filho *et al.*, 2018; Hermanson *et al.*, 2020) [30, 21].

Blood vessels and nerves supplying the prostate are encountered bilaterally at the dorsolateral surface of the prostate.

The prostatic arteries originate from the internal pudendal arteries (Fig. 2). Before they enter the dorsolateral prostate, they give rise to branches supplying the rectum, the ductus deferens, the caudal portions of the bladder and ureters, and the pelvic part of the urethra. Venous blood enters the internal iliac vein from the prostatic and urethral veins. Prostatic lymph drains into the medial iliac (sublumbar) lymph nodes. The sympathetic and parasympathetic innervations of the prostate are supplied by the hypogastric and pelvic nerves, respectively. These nerves also innervate the bladder and urethra. The hypogastric nerve arises from the mesenteric ganglion and runs alongside the arteries of the deferent ducts. The pelvic nerve joins the hypogastric nerve to form the pelvic plexus after descending from the first, second, and third sacral nerves and following the prostatic arteries (Yonese *et al.*, 2000; Smith *et al.*, 2008; Leis-Filho *et al.*, 2018) [43, 38, 30].

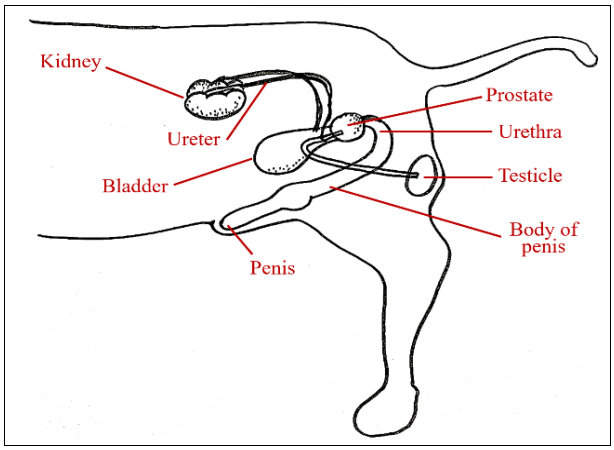

Fig 1: Urogenital organs of dog

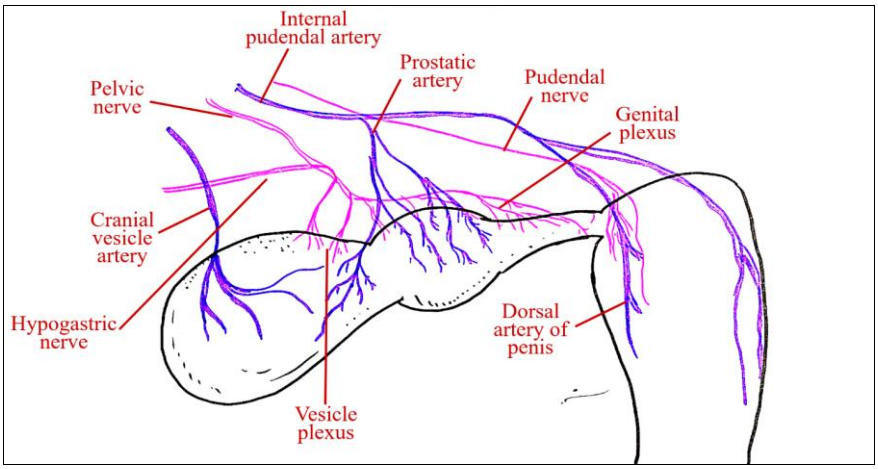

Fig 2: Disposition of internal pudendal artery, cranial vesicle artery, pelvice nerve, hypogastric nerve and pudendal nerve in dog

Sympathetic stimulation of the prostate causes ejection of prostatic fluid, while parasympathetic stimulation causes an increase in glandular secretion. The bladder's parasympathetic innervation is crucial for preserving the detrusor muscle's ability to contract. Sympathetic innervation regulates both the smooth muscle tone of the urethra and the internal urethral sphincter. Innervation of the external urethral sphincter is supplied by the pudendal nerve, which is also located close to the cranial prostate and bladder neck (Freitag *et al.*, 2007; Hermanson *et al.*, 2020) [14, 21].

Common prostatic diseases

Prostatic diseases are mostly observed in older, male dogs. It seems that there is no breed predisposition for prostate disease, but large-breed dogs like German Shepherds and Dobermans seem to have a higher incidence rate of the condition, though no clear cause has been identified. Ballotta and Cunto (2018) [2] have classified the prostatic pathologies into four categories: endocrine, inflammatory (septic and non-septic), neoplastic, and traumatic. Benign prostatic hyperplasia (BPH), prostatitis, prostatic cysts, prostatic abscessation, and prostatic neoplasia are the prostatic diseases that will be covered in this article.

1. Prostatitis

Mature male dogs are usually affected by acute prostatitis,

which frequently manifests as systemic disease (e.g. anorexia, fever, and depression). The majority of male dogs possess adequate defense mechanisms that shield the prostate from external infections. Prostatitis can happen, though, if the prostate is damaged by BPH or cysts. Although hematogenous spread is also possible, bacteria that colonize the prostate most often do so by ascending up the urethra. Moreover, acute prostatitis can result from cystitis spreading to the prostate (Johnston *et al*., 2001) [25].

The bacteria Escherichia coli is the most frequently isolated type. In addition, Mycoplasma, Staphylococcus, Streptococcus, Klebsiella, Proteus mirabilis, Pseudomonas, and Brucella canis are among the other bacteria that are frequently isolated. Prostatitis in dogs is rarely caused by fungal infections such as blastomycosis and cryptococcosis. Dogs suffering from acute prostatitis may exhibit depressive symptoms, pain when the prostate is palpated rectal, fever, difficulty urinating or defecating, a "stiff-legged" gait, haematuria, oedema of the scrotum, prepuce, or hindlimb, and pollakiuria. There could be one, a few, or all of these indicators. Septic shock symptoms can also be displayed by dogs suffering from prostatic abscessation, peritonitis, or septicemia. Dogs with chronic prostatitis may not exhibit any symptoms at all, or they may include infertility, poor semen quality (lower percentage of motile or morphologically normal sperm in the ejaculate), and occasionally decreased libido if prostatic contraction causes pain (Smith, 2008) [38].

Urine may have bacteria, leukocytes, or blood in it, just like in acute prostatitis. If a lower urinary tract infection is suspected in dogs with chronic prostatitis, they may need to see a veterinarian. The history, physical examination, transrectal examination, diagnostic imaging, hematology, urinalysis, prostatic fluid analysis, and bacterial cultures are all used to make a diagnosis. On palpation, the prostate is normally normal to slightly enlarged and will often be extremely painful. Prostatic echodensity may be seen to be diffusely increasing on ultrasonography, with a gradual increase in prominence. Rarely, mineralization within the prostate or signs of prostatomegaly may be visible on an abdominal radiograph. Pyuria and bacterial activity are frequently detected in urine assays. To facilitate the easier interpretation of culture results, it is crucial to obtain a urine sample through cystocentesis whenever possible. Numerous neutrophils with signs of ingested bacteria will be found during a prostatic fluid analysis. There will be signs of suppurative inflammation in the prostatic fluid obtained through ejaculation or prostatic washing. Culture of prostatic fluid generally yields the growth of a single organism in >70% of cases (Johnston *et al.*, 2000; Kustriz and Klausner, 2000) [24, 29].

Bacterial prostatitis must be treated for an extended period of time using antibiotics that the bacteria are susceptible to. The selection of antibiotics ought to be guided by factors such as antibiotic pharmacokinetics, culture, and sensitivity. Because of the pH differences between the blood and the prostatic fluid, the lipid solubility, and the protein binding properties of antibiotics, many antibiotics have difficulty penetrating the prostate. Treatment should continue for at least 4–6 weeks. Cultures of the prostatic and urine fluids should be performed 30 days after the therapy concludes in order to confirm that the infection has cleared up. More basic (pH > 7.4) antibiotics, such as trimethoprim and erythromycin, will be able to pass through the blood–prostate barrier more easily than their acidic counterparts. Nevertheless, regardless of their pH, fluoroquinolones can also enter the prostate. Furthermore, medications that are poorly lipid soluble cannot pass the prostatic acini, whereas medications that are highly lipid soluble, such as trimethoprim-sulfa, chloramphenicol, and fluoroquinolones, can pass through them with ease. (Memon, 2007) [33]. Castration is recommended as an adjunct to the medical management of prostatitis, since infection is more quickly controlled in castrated versus intact males (Sirinarumitr *et al.*, 2001) [37].

2. Prostatic cyst

Prostatic cysts can develop as a result of blocked canaliculi, which causes prostatic fluid to build up and may be linked to BPH. Dogs with concurrent BPH or other prostatic pathologies frequently have cysts. The early cystic alterations can be identified histologically. But these cysts are referred to as prostatic cysts when they start to interact with one another and become visible at a macroscopically. Retention cysts and paraprostatic cysts are the two types of cysts. When cavitating lesions are created within the prostate parenchyma, they fill with fluid and eventually form retention cysts. Normally, these cysts can communicate with the urethra. The remnants of the uterus masculinus have been linked to paraprostatic cysts, which are located outside the prostate. These paraprostatic cysts can be palpated transabdominally and are frequently very large. Usually, a tissue stalk or adhesions hold them to the prostate. Usually, an ultrasound examination of the prostate is used to diagnose prostate cysts. Radiography and transrectal palpation may not be able to identify small cystic structures because they may not change the prostate's shape. Abdominal palpation may reveal very large paraprostatic cysts; however, ultrasonography should be used to confirm the diagnosis (Smith, 2008) [38].

In a study conducted by Black *et al.* (1998) [5] in large-breed adult dogs, prostatic cysts were prevalent in about 14% of cases, and 42% of those cases showed signs of bacterial infection. This investigation emphasizes how crucial it is to perform a prostate ultrasound examination, even on dogs who do not exhibit any symptoms of prostate disease. Surgical debridement, omentalization, marsupialization, and the implantation of surgical drains are all part of the conventional treatment for prostatic cysts. Although problems are fairly common, these therapies can often be effective. More recent methods that use ultrasound guidance to drain cysts are starting to gain acceptance as a viable treatment option. Aspiration guided by ultrasound has several advantages over surgery, such as reduced morbidity, decreased expenses, and better results (Boland *et al.*, 2003) [6].

Dog owners should be advised, though, that there is a chance that bacteria will enter the needle tract because in one study, 42% of cysts contained bacteria (Black *et al.*, 1998) [5]. Additionally, dog owners must be informed that recurrence is common as well as multiple drainage procedures might be required to fully resolve the clinical signs. Aspirating the contents of the cyst is advised in addition to treatment with finasteride or castration to reduce the size of the prostate. The surgeon's decision and the dog's physiological state will determine whether to castrate the dog at the time of aspiration or after two weeks of recuperation.

3. Prostatic abscess

Chronic prostatitis can lead to pockets of purulent fluid in the prostate's parenchyma, which is known as prostatic abscessation. As an alternative, they might appear as a result of a prostatic cyst secondary infection. Prostatic infections are most frequently caused by Escherichia coli. Numerous

bacteria have also been isolated from prostatic abscesses, including Proteus spp., Klebsiella spp., Streptococcus spp., Staphylococcus spp., Pseudomonas spp., Mycoplasma spp., and Brucella spp. a variety of factors such as the size of the abscess and whether the infection has spread across the entire body, the clinical signs may fluctuate frequently (Freitag *et al.*, 2007) [14].

Pressure on the colon or urethra may cause tenesmus or dysuria in dogs with very large prostatic abscesses. Dogs with prostatic abscesses frequently exhibit urethral discharge, whether it is regular or irregular. Upon rectal examination, there may be a doughy, asymmetric enlargement of prostate. Inflammatory leukograms are common laboratory findings. The only consistent change in serum biochemistry is hypoglycemia in cases of severe sepsis. When a urinary tract infection coexists, it increases the likelihood that prostatic abscesses from the same organism are present. A bacterial culture of prostatic fluid and prostate ultrasonography are typically used to make the diagnosis. During a routine prostate scan, the cavitating lesions are usually easily visible. An enlarged prostate that may or may not be painful is usually revealed by palpation. When the abscess is close to the gland's edge, palpable areas of fluctuance may be present (Smith, 2008) [38].

Prostatic abscesses require drainage and adequate antibiotic therapy. Intact dogs should be castrated to decrease prostatic fluid secretion and speed up the resolution of the bacterial infection. The use of antibiotics alone is thought to be noncurative because ischemia frequently prevents the drugs from penetrating abscesses. Treatment of prostatic abscessation is aimed at drainage of the abscess, either with ultrasound guidance or at surgery. In a study conducted by Boland *et al.* (2003) [6] thirteen dogs with prostatic cysts or abscesses received ultrasound-guided percutaneous drainage as their main course of treatment; after a median of thirty-six months, all of the dogs showed resolution. For prostatic abscesses, surgery is usually the preferred course of care. Partial prostatectomy, marsupialization of the prostate, and insertion of penrose drains into the abscess are possibilities for surgery (Fig. 3). Urinary incontinence and peritonitis are risks associated with all treatments. Antibiotics that are suitable for the patient's culture and sensitivity level should always be used in addition to other therapies.

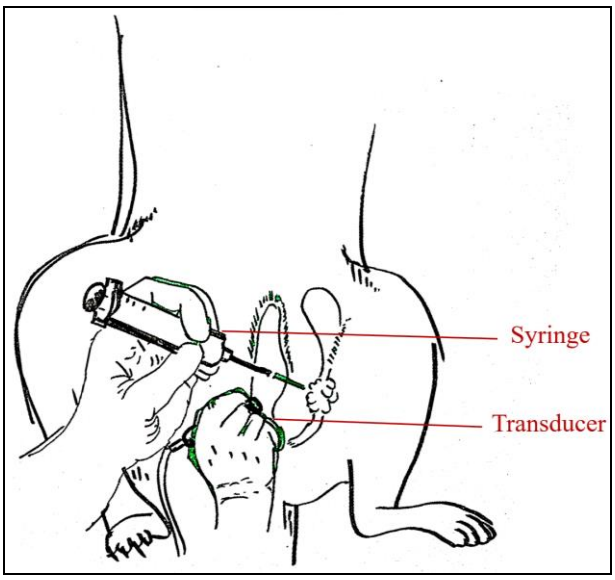

Fig 3: Transcutaneous prostatic drainage in dog guided by ultrasound

4. Prostatic Neoplasia

The incidence of neoplasm in prostate is fortunately uncommon, although Memon (2007) [33] reported in his study that among all dogs affected with prostatic disease, 5-7% exhibited prostatic neoplasia. Dogs with prostatic neoplasia were diagnosed at an average age of ten years. Regretfully, clinical symptoms of prostatic tumors are frequently not noticed until after local or regional metastases have already taken place. Dogs that are castrated may be slightly more likely than intact dogs to develop prostatic neoplasia, which is the most common prostatic disorder in these animals. Prostatic neoplasia affects middle-aged and older dogs more frequently than it does younger dogs (Teske *et al.*, 2002) [40].

The most common prostatic tumors in dogs that are diagnosed are adenocarcinomas of the prostate and transitional cell carcinomas of the prostatic urethra. Dogs between the ages of 8 and 10 years tend to be diagnosed with adenocarcinomas, and very young dogs have a low incidence with them. When compared to healthy dogs, castrates have an equivalent or higher frequency of prostatic neoplasia, suggesting that castration has no preventive effect on the canine prostate in terms of neoplasia (Bryan *et al.*, 2007) [7].

In addition to prostatic neoplasia, healthy dogs frequently exhibit histological evidence of BPH. Depending on the extent of invasiveness, presumed metastasis, and the timing of diagnosis, prostatic neoplasia can present with a variety of clinical symptoms. The most typical clinical manifestations include hematuria, tenesmus, anorexia, weight loss, stranguria, and frequently weakness in the lower limbs. Pain and neurological deficiencies in the lower limbs are frequently linked to metastases to the pelvic bones and local lymph nodes (Gobello and Corrada, 2002) [17].

On ultrasonography, prostate tumors appear as one or more hyperechoic lesions with uneven, asymmetrically enlarged margins (Nyland and Matton 2002) [34]. Though in advanced cases it may be in the abdomen due to its growing size, the prostate is normally still located in the pelvic canal. In cases where a castrated male has a palpable prostate during a transrectal exam, further diagnostic testing should be carried out to rule out prostatic neoplasia. Prostatic mineralization, regional lymphadenopathy, prostatomegaly, and signs of metastasis to the lungs and skeleton are among the radiographic findings that can be seen in dogs with prostatic neoplasia. Ultrasonography or digital guidance is used to obtain prostate biopsies. It is known that there are five histologic grades of adenocarcinomas, with the poorly differentiated ones being more common in castrated dogs (Smith 2008) [38].

Prostatic neoplasia in dogs is extremely tedious to treat, and no therapy has been proven to significantly increase survival times. Unfortunately, dogs are generally diagnosed late in the course of the disease and effective treatment options are limited. The use of radiation has been used to shrink prostate size, but it is frequently not logistically feasible and does not extend survival times. For dogs who do not exhibit metastases, a total prostatectomy may be a curative surgical procedure. On the other hand, microscopic metastasis is frequently visible during surgery. Moreover, postoperative urine incontinence following a total prostatectomy is frequently linked to (Goldsmith and bellenger, 1991) [19].

5. Benign Prostatic Hyperplasia

A spontaneous disease that starts as glandular hyperplasia as early as three years of age in male dogs that are in good health is known as benign prostatic hyperplasia. It is important to

remember that BPH is an inevitable consequence of aging, that further involves hyperplasia and hypertrophy (Francey, 2010) [13]. There are histological variations between the two species, despite the fact that this condition affects both humans and dogs. Approximately 95% of intact male dogs will have BPH by the time they are 9 years old. Most, though, won't experience any clinical symptoms related to BPH (Gobello and Corrada, 2002; Dhivya *et al.*, 2012; Becha *et al.*, 2017; Gautam *et al.*, 2019; Dwivedi *et al.*, 2021) [17, 10, 4, 15, 44].

5.1 Epidemiology

Breeds that are large in stature, like Labrador Retrievers, German Shepherds, Dobermans, and Rhodesian Ridgebacks, seem more susceptible to BPH. It is evident that the pathogenesis of BPH starts with a change in the androgen:estrogen ratio secreted by the testes. However, the exact cause of BPH remains unknown (Wolf *et al.*, 2012; Das *et al.*, 2017; Dwivedi *et al.*, 2021) [42, 8, 44].

5.2 Patho-physiology

An abnormal ratio of androgens to estrogens, an increase in androgen receptors, and an increase in tissue sensitivity to androgens are all possible causes of benign prostatic hyperplasia (BPH). Dihydrotestosterone, which is produced irreversibly from testosterone, is the main androgen that promotes hyperplasia. 5-alpha reductase is the enzyme that causes conversion in epithelial cells. Dihydrotestosterone promotes growth in the glandular and prostatic stromal components. While estrogen levels stay constant and trigger nuclear dihydrotestosterone receptors, testosterone levels decrease with age. This could lead to an increase in the prostate's sensitivity to dihydrotestosterone. It's thought that other hormones, such as growth hormone, prolactin, and estrogen, are involved. Complex or glandular hyperplasia is possible. In dogs, glandular hyperplasia manifests as early as one year of life and peaks between five and six years of age. The gland consistency is normal, and there is a uniform proliferation of secretory structures with glandular hyperplasia. Though it usually manifests between the ages of 8 and 9, complex hyperplasia can be observed in dogs as young as 2 years old. There are heterogeneous epithelial cells in cystic dilated alveoli, ranging from functional to non-functional cuboidal cells. Acini contain eosinophilic material, and the hyperplastic stroma contains plasma cells and lymphocytes (Fossum, 2018) [12].

5.3 Clinical sign

Dogs with prostate hyperplasia start to show symptoms at two years of age. They have symmetric, asymptomatic hypertrophy that is non-painful and has a normal consistency. Due to the colon's dorsal displacement against the sacral vertebrae, medical cases may also exhibit urethral discharge, hematuria, rectal tenesmus, and constipation. Perineal hernias are uncommonly the result of these expulsive actions. The reason behind the edema of the hindlimbs with a balanced and steep gait is an increase in the size of the prostate (Khadidja and Adel 2017) [45].

In 2.7% of cases of benign prostatic hyperplasia, symptoms related to the urinary system are present, whereas in 9.2% of cases, there are digestive symptoms. A study published in 1995 by Read [36] suggested that the only clinical sign of benign prostatic hyperplasia in dogs might be umbilical urethral discharge. Hespermia and hypofertility can happen without any overt clinical symptoms. A rectal examination reveals a symmetrical, painless prostate with a discrete or moderate prostatomegaly (Khadidja and Adel 2017) [45].

5.4 Diagnosis

5.4.1 Clinical Presentation Signalment

Canines that are sexually healthy are impacted. Doberman Pinschers, Scottish Terriers, Bouvier des Flandres, Bernese Mountain Dogs, and German Pointers may be predisposed to BPH. The majority of male dogs who are sexually intact and older than six years age have the disease. Mean age at diagnosis is 8.9 years for most prostatic diseases (Fossum, 2013) [12].

5.4.2 History

Hematuria, urethral hemorrhage, and/or tenesmus are possible in dogs. Owners may notice stools that resemble ribbons.

5.4.3 Physical Examination Findings

The most effective technique for doing a physical examination of the prostate is transrectal digital palpation. Prostate access is easiest when one hand is used to push the neck of the bladder and prostate into the pelvic canal and palpate the caudal, ventral abdomen. Concurrently, a digital examination of the caudal aspect of the prostate gland is conducted using the index finger of the other hand. Size, shape, symmetry, and signs of pain should all be assessed in relation to the prostate gland. A digital exam reveals that a normal prostate is painless, symmetrical, and smooth. For individuals with limited experience, the prostate's dorsal sulcus can serve as a helpful landmark because it is readily palpable. Further tests like radiography, ultrasonography, cytology and microbiology of prostatic fluid, and prostatic aspiration or biopsy can be carried out in accordance with the results of these examinations (Smith, 2008) [38].

5.4.4 Prostatic radiography

The prostate appears symmetrically enlarged on radiography. If, on lateral radiographs, the prostate occupies more than 70% of the space between the sacral promontory and the pubis, the prostate is deemed enlarged. Both the colon and the bladder may be dislocated dorsally and cranially, respectively. On the other hand, contrast radiography makes the bladder visible, which offers a landmark for locating the prostate. While the prostatic portion of the urethra can be seen with a retrograde urethrocystogram, the bladder can only be identified with a contrast cystogram. The prostatic urethra's diameter is not very useful in identifying disease states because it can differ between healthy and diseased prostate glands. An excretory urogram, which assesses ureteral patency, may be beneficial in dogs with a grossly enlarged prostate, particularly in those that show indications of renal compromise (Smith, 2008) [38].

5.4.5 Prostatic ultrasonography

When assessing the prostate gland, ultrasonography is a highly useful diagnostic technique. Visualizing the internal architecture, external texture, and cystic structures within the prostate can be greatly aided by it. When performing an aspiration or percutaneous biopsy, ultrasound is also a very helpful tool for guidance. It is possible to measure and track the gland's length, width, and depth over time. When the dog is in a dorsal or lateral recumbency position, obtaining a prostatic image is typically simple and doesn't require sedation (Kamolpatana *et al.*, 2000) [26]. One landmark that is utilized is the bladder. The echodense pattern of the prostate ought to be uniform. The homogeneous nature of the prostate

image is lost in cases of inflammation, hyperplasia, or neoplasia, and focal to multifocal areas of hyperechoic and/or hypoechoic tissue become visible (Smith, 2008) [38].

5.4.6 Prostatic fluid evaluation
When diagnosing prostatic disease in dogs, semen evaluation, especially of the third fraction can be a highly fruitful diagnostic procedure. Semen is an excellent sample for cytology and microbiological culture because the prostatic component of the fluid volume of semen is more than 90%. The third fraction's cytology is extremely specific to the prostate. The prostatic fraction of a typical male occasionally contains white blood cells, red blood cells, and squamous epithelial cells. On the other hand, a high leukocyte count suggests inflammation, while a high erythrocyte count indicates recent bleeding. As an alternative, blood may be observed in the prostatic fluid, giving the impression of coffee grounds, which would indicate ongoing hemorrhage. In more than 80% of cases, prostatic fluid inflammatory changes are linked to histological inflammation (Kustritz, 2006) [28].

5.4.7 Prostatic massage
A very good technique to obtain samples for cytology and bacteriology is to massage the prostate and immediately wash it. When a dog finds it difficult to ejaculate because of pain, fear, or lack of interest, this technique is especially helpful.

5.4.8 Prostatic biopsy
Histological analysis of a prostatic biopsy is the gold-standard test for identifying prostate-related disease processes. When less invasive diagnostic tests are unable to identify the condition, when a patient has not responded to first treatment, or when a diagnosis must be made right away in order to start treatment right away, a biopsy is necessary. Approximately 66% of cases involving prostate biopsies result in a diagnosis, compared to 50% in cases involving fine-needle aspirates. Biopsy specimens can be harvested via percutaneous means or surgically. It is necessary to submit all biopsies for histopathology. Hematuria resulting from urethral injury and bleeding is the most frequent side effect of prostate biopsies. More serious side effects include the spread of cancerous cells throughout the instrument tract or peritonitis brought on by bacteria that sprang from an abscess. Potential prostatic abscesses and acute prostatitis are the main reasons why a prostate biopsy should not be performed. Fortunately, less invasive diagnostic methods can typically be used to diagnose these conditions (Smith, 2008) [38].

5.4.9 Serum biomarkers
CPSE is a trypsin like enzyme and one of the most important serum biomarkers in the canine male genital tract (Johnston, 1991) [23]. A higher CPSE has recently been observed in dogs with various prostatic diseases, including prostatic carcinoma, bacterial prostatitis, and benign prostatic hyperplasia (BPH) (Gobello *et al.*, 2002; Levy *et al.*, 2014) [16, 31]. Since CPSE is thought to be the most representative marker of prostate secretion activity, measuring serum levels of it during BHP may be useful for diagnosis (Levy *et al.*, 2014; Pinheiro *et al.*, 2016; Holst *et al.*, 2017) [31, 35, 22]. Current research has linked the prostate's echographic results, with particular emphasis on the actual versus normal estimated volume ratio (V-ratio) and the serum CPSE, which can be either symptomatic or asymptomatic. Seventy-nine intact male dogs were enrolled in a prospective study that utilized the diagnostic potential of CPSE. According to the study's authors, a serum CPSE of at least 90 mg/ml and a V-ratio of at least 2.5 should be anticipated in symptomatic patients (Holst *et al.*, 2017) [22].
In a study conducted by Alonge *et al*. 2018 CPSE threshold was established to identify asymptomatic dogs that have already been affected by ultrasonographically detectable signs of prostatic alterations that may require additional clinical investigations. This defined the role of CPSE in a broader concept of preventive screening for canine prostatic health. 60% of the nineteen patients who were enrolled in this prospective study had ultrasonographic prostatic alterations, despite the fact that none of the patients had any symptoms. The presence of abnormal prostatic findings on ultrasonography was significantly correlated with the concentration of CPSE. The ROC curve (AUC=0.974, SE 95.6%, SP 89.2%) supported the 52.3 ng/ml cut-off CPSE threshold as a means of early detection of asymptomatic dogs exhibiting sonographic alterations and thus necessitating additional evaluations prior to their clinical illness. V ratios in the study showed that normal dogs had a ratio less than 1.5, whereas dogs in need of additional evaluations had a ratio greater than 1.5. Additionally, significant elevation in concentrations of prostate specific antigen (PSA), and dihydrotesterone, CPSE along with prostate volume have also been reported in induced prostatic hyperplasia in dogs (Golchin-Rad *et al.*, 2019) [18].

5.5 Treatment
5.5.1 Medicinal therapy
Right now, finasteride—a synthetic steroid type-II 5 α-reductase inhibitor is the most often prescribed medication for benign prostatic hyperplasia (BPH). It has been used for more than ten years in human urology to treat BPH. When castration is not an option, it is currently the preferred medical therapy for dogs. The process that turns testosterone into dihydrotestosterone is blocked by finasteride (Gobello and Corrado, 2002) [17]. Prostatic diameter, prostatic volume, and serum DHT concentration are all reduced by 20, 43, and 58%, respectively, with finasteride after 16 weeks of treatment (Johnston *et al.*, 2001) [25]. Dogs receiving finasteride saw a decrease in semen volume, but there was no change in semen quality or quantity (Sirinarumitr *et al.*, 2001) [37].
For 16 weeks, the finasteride dosage in the aforementioned study was 0.1–0.5 mg/kg PO every 24 hours. Similar outcomes were obtained with a much higher dose in earlier studies. Two months after finasteride is stopped, the prostate of treated dogs reverts to its pre-treatment size. Finasteride is currently the best medical treatment option available for the valuable breeding dog due to its efficacy and safety. In most dogs (84%), medroxyprogesterone acetate (3 mg/kg intramuscularly) reduces hyperplasia symptoms in 4 to 6 weeks, but the signs return after an average of 13.6 months. Increased appetite, weight gain, mammary neoplasia and dysplasia, and diabetes mellitus are possible side effects of progestin use. The hypothalamic-pituitary-gonadal (HPG) axis is suppressed by estrogens, which lowers blood testosterone levels and eventually shrinks the prostate. It has been used to administer injectable and oral medications such as estradiol cypionate (ECP) and diethylstilbestrol (DES). Due to the possibility of harmful side effects and the availability of safer alternatives, even though the results were similar to those of the medroxyprogesterone acetate treatment, it is no longer advised to use them. Recent research has demonstrated that antiandrogens such as osaterone acetate (1-3 mg/kg subcutaneously, every month) and delmadinone acetate (antiandrogens) can both improve clinical symptoms

and induce clinical remission with only mild side effects. Osaterone also reduces prostatic gland volume more quickly than delmadinone (Socha *et al.*, 2018) [39].

Studies also suggest use of phosphodiesterase inhibitors like Tadalafil for the treatment of canine BPH. When dogs with experimentally induced BPH, treated with Tadalafil (5mg/day orally), exhibited significant differences among the normal dogs as compared to BPH-castrated, BPH-Tadalafil, and BPH groups for the values of PSA, CPSE, and PAP (prostatic acid phosphatase) concentration (Dearakhshandeh *et al.*, 2020) [9].

5.5.2 Surgical therapy

The best way to treat dogs with BPH and eliminate the hormone influence is through castration. Following surgery, a 70% reduction in size results from castration. After castration, the prostate starts to shrink in 7-14 days, but it might take up to 4 months for full involution. (Sirinarumitr *et al.*, 2001) [37].

5.5.3 Subtotal Prostatectomy

By making a ventral or ventrolateral capsular incision and using a sharp, blunt dissection tool, abnormal prostatic tissue can be removed. Hemostasis can be made easier and more accurate tissue resection is possible with the use of surgical lasers, electro scalpels, and electrocoagulation equipment. The major blood vessels supplying the prostate can be extracapsular tied off to control severe hemorrhage, and the terminal aorta can be temporarily bandaged. Dissection dorsolateral to the prostate, however, ought to be avoided as it increases the risk of bladder and urethral neurovascular injury and consequent incontinence. Ultrasonic aspiration can be used to remove abnormal prostatic parenchyma. There have been a few cases of non-invasive subtotal prostatic ablation in dogs documented. During this procedure, prostatic tissue is specifically destroyed using high-intensity focused ultrasound that is delivered via a transrectal probe. Urine outflow obstructions in dogs with prostatic neoplasia have been reported to temporarily improve following transurethral resection. Transurethral resection is only possible in medium- to large-breed dogs and requires specialized cystoscopic equipment and technical skills (Freitag *et al.*, 2007) [14].

Conclusion

Prostatic diseases, including prostatitis, prostatic cysts, abscesses, neoplasia, and Benign Prostatic Hyperplasia (BPH), become more common with age, particularly in intact males over six years. Various diagnostic tools, including physical exams, imaging, and fluid analysis, contribute to precise identification. Treatment approaches vary, ranging from antibiotics and surgery to castration. Specific diseases like prostatitis, cysts, abscesses, and neoplasia present unique challenges, with prostatic neoplasia posing diagnostic difficulties and limited treatment options. BPH, a prevalent age-related condition in intact males, particularly large breeds, can be effectively managed with medical therapies like finasteride, which reduces prostatic size. However, castration remains the definitive treatment, causing a significant reduction in prostate size.

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