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Canine prostatic disease: A review of anatomy, pathology, diagnosis, and treatment

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Abstract

Disease conditions affecting the canine prostate gland are encountered frequently in small animal practice. The most common conditions affecting the canine prostate include benign prostatic hyperplasia, prostatitis, prostatic cysts, and prostatic neoplasia. Clinical signs associated with each of these conditions often overlap; therefore, it is important to reach a definitive diagnosis prior to initiating treatment. This paper reviews the diseases associated with the prostate gland of the dog, their diagnosis, as well as current treatment options for management of these conditions. Emphasis is placed on proper diagnostic sampling of the prostate gland, its fluid, and interpretation of findings, as well as emerging medical options for treatment of canine prostatic disease.

Keywords: Prostate; Benign prostatic hypertrophy; Prostatitis; Finasteride; Dog

1. Introduction

Signs suggestive of canine prostatic disease are relatively common in male dogs, especially intact males >6 years old. The canine prostate gland can be affected by several disease processes, which often have overlapping clinical signs, making it difficult to reach the correct diagnosis. Accurate diagnosis of prostatic disease requires a thorough understanding of prostatic anatomy, as well as clinical signs associated with canine prostatic disease. Furthermore, knowing which diagnostic tests are indicated, and how to properly them, facilitates an efficient and accurate diagnostic process. In addition to standard surgical and medical treatment options for dogs with prostatic disease, there are also new and emerging treatment modalities.

2. Prostatic anatomy

The canine prostate is a bilobed structure, encircling the proximal urethra of male dogs. The gland is oval to spherical, has both a dorsal and ventral sulcus (the former can be identified with transrectal palpation), and is encircled by a fibromuscular capsule. The prostate gland is the sole accessory sex gland in the dog and is typically located in the caudal abdomen or pelvic cavity, depending on its size [1–3]. It lies in close apposition to the bladder cranially, rectum dorsally, pubic symphysis ventrally, and abdominal wall laterally. Paired ductus deferentes enter the craniolateral aspect of each prostate lobe and course caudoventrally before entering the urethra immediately adjacent to the colliculus seminalis [3]. There is typically a fibrous band of tissue that attaches the prostate to the rectum dorsally, whereas a layer of fat covers the prostate ventrally [3]. The prostatic ducts course towards the urethra and enter throughout its circumference. The prostate has a prominent median septum which separates the right

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and left lobes [2]. Each lobe is further divided into lobules by trabeculae; tubuloalveolar glands are organized within the lobules and secretions leave these glands via small ducts which empty into the urethra.

The arterial supply of blood to the prostate gland is the prostatic artery, which arises from the internal pudendal artery [2]. Arterial branches enter the prostate on the dorsal or dorsolateral surfaces of the gland, penetrate the capsule, and supply the glandular tissues [3]. The venous supply is in close proximity to the arterial vessels and drains by way of the prostatic and urethral veins into the internal iliac vein. Lymph vessels empty into the iliac lymph nodes. Innervation to the prostate is via the hypogastric nerve (sympathetic control) and pelvic nerve (parasympathetic control) [3].

The prostate of prepubertal male dogs is typically only a small enlargement encircling the proximal urethra [2]. As puberty approaches and blood testosterone concentrations increase, it begins to grow and assume its mature size. With age and continued exposure to testosterone, the prostate gland begins to undergo hyperplasia and further increases in size. The volume of a normal mature dog's prostate can be accurately calculated as follows: volume (cm^3) = {0.867 × BW (kg)} + {1.885 × age (year)} + 15.88 [4].

The precise function of the prostate gland has not been clearly elucidated. Its major role is production of prostatic fluid, which aids to both support and transport sperm during ejaculation [1]. Secretions produced by the gland contain citrate, lactate, and cholesterol, but surprisingly, they lack a simple sugar that is present in the prostate of most other species [3]. Therefore, the source of a readily available energy supply for canine sperm is unknown.

3. Clinical signs and physical examination in dogs with prostatic disease

The patient that presents with symptoms or signs suggestive of prostatic disease should have, at a minimum, a thorough history, complete physical examination, and digital rectal examination. Owners should be questioned regarding urination and defecation patterns. In that regard, it is common for dogs with an enlarged prostate to have ribbon or tapered stools, due to compression of the rectum by the enlarged prostate. Furthermore, these dogs will often also have tenesmus associated with defecation. Urinary signs such as hematuria and preputial or urethral discharge are common in dogs with prostatic disease [1,2,5–8].

Transrectal digital palpation is the best method for physical examination of the prostate. The prostate is most easily reached when one hand is used to palpate the caudal, ventral abdomen and push the neck of the bladder and prostate into the pelvic canal. Simultaneously the index finger of the other hand is used to perform a digital exam of the caudal aspect of the prostate gland. The prostate gland should be evaluated for size, shape, symmetry and evidence of pain [2,5,6]. The normal prostate is smooth and symmetrical in shape, and free of pain on digital exam. The dorsal sulcus of the prostate is easily palpable and can be a useful landmark for those with limited experience.

Depending on the findings of these examinations, additional procedures such as radiography, ultrasonography, cytology and microbiology of prostatic fluid, and prostatic aspiration or biopsy can be performed [1,2,5–8]. Furthermore, in suspected cases of prostatic disease, in is prudent to also include a CBC and serum chemistry panel, as well as a urinalysis.

3.1. Prostatic radiography

Survey radiography is of limited value for diagnosis of specific prostatic diseases; however, it can be used to determine the size, shape, contour, and location of the prostate. Both lateral and ventrodorsal views of the caudal abdomen are done. The size of the normal prostate should not exceed 50% of the width of the pelvic inlet on a ventrodorsal radiograph [9]. Prostatic enlargement of >90% of the pubic brim–sacral distance indicates likely prostatic neoplasia, abcessation, or prostatic cyst [9]. There is often poor contrast in the caudal abdomen, making it difficult to clearly visualize the prostate on survey films [5,6]. However, contrast radiography allows the urinary bladder to be visualized, providing a landmark for identifying the prostate. A contrast cystogram makes the bladder identifiable, whereas a retrograde urethrocystogram will enable visualization of the prostatic portion of the urethra. The diameter of the prostatic urethra can vary in both normal and diseased prostate glands, and therefore is of limited value in determining disease states.

In dogs with a grossly enlarged prostate, an excretory urogram (to evaluate ureteral patency) may be valuable, especially in dogs that exhibit signs of renal compromise. Contrast radiography can also be used to determine whether a cystic structure is located within the prostate gland or is paraprostatic. Furthermore, thoracic and abdominal survey films should always be performed in any dog in which there is evidence of prostatic neoplasia, due to the common metastasis to pelvic lymph nodes, vertebral bodies, and lungs [2,5].

3.2. Prostatic ultrasonography

Ultrasonography is an excellent diagnostic tool in evaluating the prostate gland. It is very useful for visualizing the internal architecture, external texture, as well as cystic structures within the prostate. Ultrasonography is also very useful for guidance when percutaneous biopsy or aspiration is performed. The length, width, and depth of the gland can be determined and followed over time. It is usually easy to obtain a prostatic image with the dog in dorsal or lateral recumbancy, often without the need for sedation [5,6,10]. The urinary bladder is used as a landmark. The prostate should have a homogeneous echodense pattern. In cases of inflammation, hyperplasia, or neoplasia, the homogeneous nature of the prostate image is lost, and focal to multifocal areas of hyperechoic and/or hypoechoic tissue become apparent. In contrast, anechoic areas are present in cases of prostatic cysts and hypoechoic areas in cases of prostatic abscessation [2,11].

3.3. Prostatic fluid evaluation

Semen evaluation, particularly the third fraction, can be a very rewarding diagnostic test for prostatic disease in the dog. The prostatic contribution to the total fluid volume of semen is >90%, making semen an ideal sample for cytology and microbial culture [1,11]. The ejaculate is typically collected in three fractions after manual stimulation. It is helpful, but not always essential, to have an estrual bitch present to facilitate collection. The first fraction is a pre-sperm fraction that originates from the urethra and the prostate. This first fraction is normally clear in color and the volume rarely exceeds 2 mL. The second fraction is the sperm-rich fraction that typically has a cloudy appearance (due to presence of sperm). The volume of the second fraction can vary considerably due to the size of the dog, but rarely exceeds 3–4 mL. The third fraction is solely prostatic fluid that should be clear in appearance. The volume of the third fraction is the most variable and can exceed 15 mL in normal dogs. This fraction is released over a period of 5–25 min (volume is affected by duration of collection) [11].

Cytology of the third fraction is very specific for the prostate. The occasional red blood cell, white blood cell, and squamous epithelial cell are present in the prostatic fraction of the normal male. However, the presence of large numbers of erythrocytes indicates recent hemorrhage, whereas a large number of leukocytes indicates inflammation [1,2]. Alternatively, blood may be noted as a coffee-ground appearance to the prostatic fluid, indicating chronic hemorrhage. It is important to look for bacteria-laden white blood cells, indicative of active infection [12]. Inflammatory changes in prostatic fluid are associated with histological inflammation in >80% of cases [1].

Bacterial culture of the ejaculate must be interpreted carefully, due to the presence of normal flora in the distal urinary tract. It is important to quantify the bacterial count and isolate the type of bacteria present to correctly interpret the findings [11,12]. Culture of gram-positive bacteria at concentrations <100,000/mL should be viewed with caution, as should growth of several bacterial species. Conversely, heavy growth of a pure culture of gram-negative bacteria often indicates infection. Prostatic infection was defined in one study when there was growth of bacteria $\geq 2 \log_{10}$ of one or more bacterial species in the prostatic fluid of the same dog in paired urethral specimens [12].

3.4. Prostatic massage

Prostatic massage, immediately followed by a prostatic wash, can be a very good technique to obtain samples for cytology and bacteriology. This technique is especially useful in the dog in which an ejaculate cannot be easily obtained, due to lack of interest, fear, or pain [1,2,6,11]. In cases where prostatic neoplasia is suspected, prostatic massage and wash are more likely to obtain neoplastic cells than is an ejaculated sample.

To perform a prostatic massage, the patient is sedated or anesthetized and the urinary bladder is catheterized in an aseptic manner. All urine is removed (some is retained for urinalysis) and the bladder is rinsed with saline several times and emptied. A small volume of residual saline is collected for a pre-massage sample. A sterile urinary catheter is placed in the prostatic urethra via transrectal guidance. The prostate is then vigorously massaged transrectally, followed by the slow injection of 10 mL of saline through the catheter. It is important to occlude the urethral orifice so that the fluid is not lost out the urethral opening [11]. Then, continuous aspiration is applied as the catheter is advanced through the prostatic urethra and into the urinary bladder. Aspirated fluid is recovered in a sterile syringe and submitted for cytology and quantitative microbial culture. The pre-massage sample should be submitted as well and results compared to the post-massage sample [1,2,6,11].

3.5. Prostatic fine-needle aspiration

Fine-needle aspiration can be used to collect both fluid and tissue for cytological evaluation and microbial

culture, and to drain fluid from cystic lesions within or exterior to the prostate. The major contraindication for aspiration is the presence of prostatic abscessation, due to the possibility of seeding the needle tract with bacteria. In a study of 13 dogs with either prostatic abscesses or cysts in which the primary treatment was percutaneous ultrasound-guided drainage, there were no complications after drainage [13].

Aspiration is typically performed via transabdominal ultrasound guidance, with the sedated dog in lateral or dorsal recumbency [11,13]. However, perirectal and rectal prostatic aspiration have been described. A spinal needle with stylet is typically used and suction applied with a syringe [1,11].

Fluid that is collected is evaluated both cytologically and for microbial growth. Aspiration of any fluid from the prostate should be considered abnormal. Normal prostatic fluid is very minimal in amount, light yellow and translucent, and resembles urine. If unsure of the exact location of the needle at the time of aspiration, it is prudent to compare the sample to a urine sample to rule out inadvertent puncture of the urinary bladder or prostatic urethra.

If only tissue is collected in the lumen of the needle, it should be expressed on a slide and an impression smear made. The slide should then be evaluated by a pathologist.

3.6. Prostatic biopsy

The gold-standard test for determining disease processes involving the prostate is histological examination of a prostatic biopsy. A biopsy is warranted in cases in which less invasive diagnostic tests do not render a diagnosis, when a case has been unresponsive to initial therapy, or in cases in which an immediate diagnosis is required to ensure prompt treatment [11]. Prostatic biopsy yields a diagnosis in approximately 66% of cases, in comparison to 50% in fine-needle aspirates of the prostate [11].

Biopsy samples can be obtained percutaneously or at surgery. Percutaneous prostatic biopsy is performed either via a perirectal approach or through a transabdominal approach. With the perirectal approach, the biopsy instrument is guided with simultaneous transrectal palpation, whereas the transabdominal approach is generally guided ultrasonographically [1,11]. With both approaches, the dog is typically sedated, and local anesthesia is used as needed.

A surgical biopsy is often performed in conjunction with an exploratory laparotomy. The abdomen is entered through a caudal abdominal-peripreputial approach. Prostatic biopsies can be taken with a Tru-Cut needle or with a wedge resection from a prostatic lobe. All biopsies should be submitted for histopathology.

The most common complication that occurs with biopsy of the prostate is hematuria secondary to urethral injury and hemorrhage [11]. More severe complications include peritonitis secondary to seeding of bacteria from an abscess, or dissemination of neoplastic cells along the instrument tract.

Primary contraindications to performing biopsy of the prostate include potential prostatic abscesses and acute prostatitis. Fortunately these conditions can generally be diagnosed with less invasive diagnostic techniques.

4. Common prostatic diseases

Diseases of the prostate are common in older, intact male dogs. Although there appears to be no breed predilection for prostate disease, large-breed dogs such as German Shepherd dogs and Dobermans seem to have an increased prevalence, although a causal relationship has not been established [6]. The prostatic diseases that will be discussed here include: benign prostatic hyperplasia (BPH), prostatic cysts, prostatitis, prostatic abcessation, and prostatic neoplasia.

4.1. Benign prostatic hyperplasia

Benign prostatic hyperplasia is a spontaneous disease of intact male dogs that begins as glandular hyperplasia as early as 3 years of age. It is noteworthy that BPH is part of an aging process, that includes both an increase in cell number (hyperplasia) and an increase in cell size (hypertrophy) [2,7]. Although this condition occurs in both dogs and humans, there are histological differences between species. With time, almost all intact male dogs will develop BPH, with >95% affected by 9 years of age [5]. However, most will not develop clinical signs associated with BPH.

Although the pathogenesis of BPH has not been elucidated, it is clear that BPH begins with an alteration of the androgen:estrogen ratio secreted by the testes [14]. In that regard, estrogens promote BPH by enhancing androgen receptors. An overproduction of dihydrotestosterone (DHT) within the prostate is the primary mediator for BPH [1,15]. The initial hyperplasia begins as glandular hyperplasia and subsequently transitions into cystic hyperplasia, which often leads to formation of cystic structures within the parenchyma of the prostate, giving it the typical honeycomb appearance.

There are typically no clinical signs displayed by dogs with BPH until the condition has progressed to the point that the enlarging prostate causes tenesmus or hematuria. Other clinical signs can include urethral discharge, hemospermia, or rarely a stilted gait secondary to prostatic pain [1,5,7].

Diagnosis of BPH can only be made after biopsy; however, a presumptive diagnosis is usually made based on a thorough history, physical exam findings, and prostatic fluid evaluation via semen collection or prostatic massage. Response to therapy can also be used to establish a presumptive diagnosis.

Castration is the most effective treatment for removing the hormone influence on dogs with BPH [16]. Surgical castration causes a 70% reduction in size after surgery. Although the prostate begins to shrink within 7–14 d after castration, complete involution may require 4 months [2,6,8].

Currently the most common medical treatment for BPH is finasteride, a synthetic steroid type-II 5α-reductase inhibitor which has been used in human urology for over a decade in the management of BPH [8]. Approved for treatment of BPH in men in the early 1990s, it is now the medical therapy of choice in dogs for which castration is not an option. Finasteride blocks the pathway which converts testosterone to dihydrotestosterone [5]. Finasteride decreases prostatic diameter, prostatic volume, and serum DHT concentration by 20, 43, and 58%, respectively, after treatment for 16 weeks [6,8]. Although semen volume decreased in dogs treated with finasteride, semen quality or quantity is not affected. The dosage of finasteride used in the above study was 0.1–0.5 mg/kg PO every 24 h for 16 weeks [8]. Earlier studies used a much higher dose with similar results. The prostate of treated dogs returns to approximately pretreatment size by 2 months after finasteride is discontinued. Safety and efficacy make finasteride the best medical treatment option currently available for the valuable breeding dog.

Other medical options include progestagens, which reduce testosterone concentrations through their negative feedback at the level of the hypothalamus. In a clinical study regarding the management of BPH in a hospital setting, 84% of dogs injected SQ with 3 mg/kg (minimum dose, 50 mg) of medroxyprogesterone acetate (MPA) had no clinical signs of BPH 4–6 weeks later, with 68% remaining free of clinical signs for at least 10 months [14]. However, that hypothyroidism or diabetes mellitus developed in two MPA-treated dogs raised serious concerns regarding the safety of this option for treatment of BPH.

Estrogens reduce prostatic size by suppressing the hypothalamic–pituitary–gonadal (HPG) axis, thereby reducing blood testosterone concentrations. Both oral and injectable products, including diethylstilbestrol (DES) and estradiol cypionate (ECP), have been used. Although results were comparable to that of the MPA treatment, due to the potential toxic side effects and the availability of safer alternatives, they are no longer recommended [14].

Analogs and antagonists of GnRH that reduce testosterone concentrations (via negative feedback on the HPG axis) are commonly used to manage prostatic neoplasia in men, and should be similarly effective in reducing prostatic size in dogs. However, they offer no advantage over castration and are generally very expensive [17]. A recent report regarding the use of long-acting deslorelin (Suprelorin®; Peptech Animal Health) in a sustained release subcutaneous implant to control reproduction in dogs shows promise for its use in prostate disease [18]. In 56 dogs treated in one study with the deslorelin implant, testosterone concentrations reached 0 ng/mL by 14 d in the majority of dogs and were maintained at this level for at least 180 d in 55 of the 56 dogs treated [18]. Although prostate-specific end points were not evaluated, based on blood testosterone concentrations, further research is warranted. However, these types of medication are expected to concurrently cause substantial suppression of semen quality (due to the decreased testosterone concentrations).

Tamoxifen, an antiestrogenic compound that competitively blocks estrogen receptors with a mixed antagonist–agonist effect [19], was recently studied for treatment of prostatic disease in dogs [19]. Seven dogs with spontaneous BPH were treated with tamoxifen daily for 28 d; testis, prostate, hormone, and semen end points were evaluated. There was a significant decrease in prostate size and testosterone concentrations during the study and no side effects were noted [19]. Therefore, tamoxifen may have a place in the management of BPH, although further study is needed.

4.2. Prostatic cysts

Prostatic cysts may be associated with BPH and are formed when canaliculi become obstructed, leading to accumulation of prostatic fluid [1]. Cysts are often found in dogs with concurrent BPH or other prostatic pathology. The initial cystic changes are only apparently histologically. However, as these cysts begin to communicate with each other and become evident macroscopically, they are termed prostatic cysts [20]. Cysts are classified as either retention cysts or

paraprostatic cysts [5]. Retention cysts are formed when cavitating lesions, which fill with fluid, are created within the parenchyma of the prostate. These cysts typically communicate with the urethra. Paraprostatic cysts are found outside the prostate and have been associated with remnants of the uterus masculinus [3]. These paraprostatic cysts are often very large and can be palpated transabdominally. They are generally attached to the prostate via a stalk of tissue or adhesions.

Prostatic cysts are typically diagnosed via ultrasound evaluation of the prostate. Small cystic structures may not alter the contour of the prostate, making them difficult to detect with transrectal palpation or radiology. Very large paraprostatic cysts may be palpable on abdominal palpation, but should be confirmed with ultrasonography.

The prevalence of prostatic cysts in adult large-breed dogs was approximately 14%; of those, 42% had evidence of bacterial infection [20]. This study highlights the importance of ultrasound examination of the prostate, even in dogs without clinical signs suggesting prostate disease.

Traditional therapy for prostatic cysts includes surgical debridement, omentalization, marsupialization, and placement of surgical drains [13,16]. These therapies are often effective, but complications are fairly frequent. Newer techniques using ultrasound-guided drainage of cysts are becoming an acceptable method of treatment. The advantage of ultrasound-guided aspiration includes lower morbidity, lower costs, and improved outcome versus surgery [13]. However, clients should be warned of the potential for seeding of the needle tract with bacteria, as 42% of cysts in one study had bacteria present [20]. Also, clients need to be aware that multiple drainage procedures may be needed to fully resolve the clinical signs and that relapse is common [13]. Treatment with finasteride or castration to reduce the prostate size is recommended in addition to aspiration of the cyst contents. Castration at the time of aspiration or following 2 weeks of convalescence is left to the discretion of the surgeon and the patient's clinical condition.

4.3. Prostatitis

4.3.1. Acute bacterial prostatitis

Acute prostatitis typically affects mature male dogs, which will often present with signs of systemic disease (e.g. anorexia, fever, and depression). Male dogs generally have sufficient defense mechanisms which protect the prostate from infection. However, when the prostate is compromised by BPH or cysts, prostatitis can occur. In most cases, the prostate is colonized by bacteria that ascend up the urethra, however there is also hematogenous spread [1,6,7]. Furthermore, cystitis can extend to the prostate and cause acute prostatitis. The most common bacterial isolate is *Escherichia coli*. Other bacteria which are commonly isolated include *Mycoplasma*, *Staphylococcus* spp., *Streptococcus* spp., *Klebsiella* spp., *Proteus mirabilis*, *Pseudomonas* spp., and *Brucella canis* [1,6,12]. The fungal conditions blastomycosis and cryptococcosis are infrequent causes of prostatitis in the dog [6].

Clinical signs associated with prostatitis include the generalized signs mentioned previously, as well as vomiting, caudal abdominal pain, stiff or stilted gait, preputial discharge, and possibly unwillingness to breed. Affected dogs are often overtly ill, with hematology showing a mature neutrophilia and commonly evidence of a left shift.

A diagnosis is based on the history, physical examination, transrectal examination, diagnostic imaging, hematology, urinalysis, prostatic fluid analysis, and bacterial cultures. The prostate will often be very painful on palpation and is typically normal to slightly enlarged. Ultrasonographically, there may be a diffuse increase in prostatic echodensity, which becomes more pronounced over time. Abdominal radiographs may show evidence of prostamegaly or rarely mineralization within the prostate. Urinalysis will typically reveal pyuria and evidence of bacteria. It is important to get a urine sample via cystocentesis whenever possible to make interpretation of culture results more straightforward. Prostatic fluid analysis will reveal numerous neutrophils with evidence of engulfed bacteria [1].

Ling et al. [12] described a system where bacterial colony counts were compared in urine collected via cystotomy, urethral swabs, and prostatic fluid collected via ejaculation. They defined infection of the prostate as growth of bacteria in the prostatic fluid that is $\geq 2 \log_{10}$ more than the number of colonies of the same bacterial species in the corresponding urethral sample. If the number of organisms differed by less than $2 \log_{10,}$ resampling was recommended [12].

4.3.2. Chronic bacterial prostatitis

Chronic prostatitis is somewhat more difficult to detect, since many dogs have either no or only vague signs. The most common presentation of dogs with chronic prostatitis is recurrent urinary tract infections or urethral discharge [1,6]. Occasionally, it will be diagnosed at semen evaluation, due to the presence of increased numbers of white blood cells in the ejaculate. Many of these dogs do not show any evidence

of prostatic disease and can misdiagnosed without careful evaluation. Ultrasound evaluation and prostatic fluid evaluation of these patients is helpful in making a diagnosis.

Evaluation of prostatic fluid collected either via ejaculation or prostatic wash will show evidence of suppurative inflammation. Culture of prostatic fluid generally yields the growth of a single organism in >70% of cases [1,11]. In cases of chronic prostatitis, the inflammatory component may be reduced. Results of prostatic fluid cytology and culture have generally correlated well with histology in clinical cases of prostatitis; however, tissue culture was more accurate in detecting prostatic infection [11].

Palpation of the prostate in chronically affected dogs will often reveal a normally contoured gland that is not painful, leading many to the false assumption that prostate disease does not exist. However, careful interpretation of the urinalysis, urine culture and results of prostatic fluid evaluation will generally facilitate a diagnosis. Fine-needle aspiration or biopsy of the prostate may provide valuable information, but concerns regarding potential seeding of the needle tract with bacteria should be considered, in addition to the risk of iatrogenic trauma.

Treatment of bacterial prostatitis requires prolonged treatment with antibiotics to which the bacteria are susceptible. Antibiotic choices should be based on culture and sensitivity, as well as the pharmacokinetics of the antibiotic. The prostate is difficult for many antibiotics to penetrate, due to pH differences in the blood versus the prostatic fluid, lipid solubility, and protein binding characteristics of antibiotics [1,2,6]. Treatment should continue for at least 4–6 weeks. Follow-up urine and prostatic fluid cultures should be performed prior to ending and 30 d after therapy to assure resolution of infection.

The pH of the prostatic fluid is typically <7.4 (lower than that of blood). This acidic environment makes it easier for drugs with a higher pH to enter the prostate. Antibiotics that are more basic than 7.4, e.g. erythromycin and trimethoprim, will cross the blood–prostate barrier easier than their acidic counterparts [1]. However, the fluoroquinolones can also penetrate the prostate regardless of their pH, due to their zwitterion characteristics. Additionally, highly lipid soluble drugs, e.g. the fluoroquinolones, chloramphenicol and trimethoprim-sulfa, cross the prostatic acini easily, whereas poorly lipid soluble drugs cannot cross the prostatic acini [1,21].

Castration is recommended as an adjunct to the medical management of prostatitis, since infection is more quickly controlled in castrated versus intact males [2,6,8]. The main effect of castration is the reduction of prostatic size secondary to prostatic hypertrophy. It is advisable to treat the dog with antibiotics for 5–7 d prior to castration (to reduce the incidence of scirrhous cord). In valuable breeding dogs with prostatitis and concurrent BPH, in addition to antibiotics, finasteride should also be given [8].

4.4. Prostatic abscessation

Prostatic abcessation is a sequela to chronic prostatitis; cavities of purulent fluid are found within the parenchyma of the prostate [1,6,7]. The clinical signs often vary, depending on the size of the abscess and whether the infection has become systemic. In dogs with very large prostatic abscesses, there may be signs of tenesmus or dysuria, due to pressure on the colon or urethra. Urethral discharge, whether chronic or intermittent, is a common finding in dogs with prostatic abscesses.

The diagnosis is generally made with ultrasonography of the prostate, in conjunction with bacterial culture of prostatic fluid. The cavitating lesions are generally readily visible on routine scanning of the prostate. Palpation typically reveals an enlarged prostate, which may or may not be painful. Areas of fluctuance may be palpable when the abscess is near the gland's periphery. Ling et al. [12] proposed that chronic infections and potentially abscesses could be walled off, with no direct connection with the prostatic ductal system; therefore, bacterial culture of prostatic fluid could yield false-negative results [12].

Treatment of prostatic abcessation is aimed at drainage of the abscess, either with ultrasound guidance or at surgery. Ultrasound-guided percutaneous drainage was used as the primary treatment in 13 dogs with prostatic abscesses or cysts, with resolution in all dogs over a median follow-up period of 36 months [13]. Surgery has been the traditional treatment of choice for prostatic abscesses. Surgical options include placing penrose drains in the abscess, partial prostatectomy, and marsupialization of the prostate [16]. All treatments have the risk of peritonitis and urinary incontinence. In all cases, appropriate antibiotics based on culture and sensitivity should be used in addition to other treatments.

4.5. Prostatic neoplasia

Prostatic neoplasia is fortunately rare, but occurs in 5–7% of dogs with prostatic disease [21]. The mean age

at diagnosis for dog with prostatic neoplasia was 10 years [7]. Unfortunately prostatic tumors are often not diagnosed until clinical signs are observed, and by this time, local or regional metastasis has already occurred [1,5,6]. Adenocarcinoma of the prostate and transitional cell carcinomas of the prostatic urethra are the most frequently diagnosed prostatic tumors in dogs. Adenocarcinomas are usually found in 8- to 10-year-old dogs, and only sporadically in very young dogs. Castration does not appear to have any protective effect on the canine prostate with regards to neoplasia, with castrates having the same or greater prevalence of prostatic neoplasia when compared to intact dogs [22]. Intact dogs will often also show histological evidence of BPH as well as prostatic neoplasia.

Clinical signs associated with prostatic neoplasia can vary depending on the time of diagnosis, degree of invasiveness, and potential metastasis. The most common clinical signs include anorexia, weight loss, hematuria, stranguria, tenesmus, and often weakness in the rear limbs. Metastasis to regional lymph nodes and pelvic bones is commonly associated with pain and neurological deficits in the pelvic limbs [1,5].

Transrectal examination of dogs with prostatic neoplasia often reveals an irregular, asymmetric, enlarged prostate that may be painful. The prostate is usually still in the pelvic canal, but in advanced cases, it may be in the abdomen due to its increasing size. Any time a palpable prostate is found on a transrectal exam in a castrated male, one should be suspicious of prostatic neoplasia; in these cases, further diagnostic tests should be performed to rule out neoplasia.

Radiographic findings in dogs with prostatic neoplasia can include prostamegaly, prostatic mineralization, regional lymphadenopathy, and evidence of metastasis to the lungs and skeleton [21]. Ultrasound findings are similar, but also include focal to diffuse hyperechoic areas, mineralization, and loss of normal prostatic contour.

Diagnosis of prostatic neoplasia is often made after histological confirmation in dogs with suggestive clinical signs and clinical examinations consistent with prostatic disease. Biopsies of the prostate are obtained with the aid of ultrasound or digital guidance. Five histologic grades of adenocarcinoma have been described; castrated dogs are more likely to have the poorly differentiated ones [5].

Treatment of dogs with prostatic neoplasia is very unrewarding and no therapy has been shown to markedly prolong survival times. Unfortunately, dogs are generally diagnosed late in the course of the disease and effective treatment options are limited. Dogs which concurrently suffer from BPH may benefit from castration which will effectively reduce the BPH component of the disease and often improve urinary control. Radiation therapy has been used to reduce prostate size, but does not improve survival times and is often logistically impractical. Chemotherapeutic protocols have not been very successful in the management of prostatic neoplasia. Surgical treatment options typically leave the dog with urinary incontinence and can be technically challenging. In cases of complete urethral obstruction, urinary diversion with a cystotomy may be needed. Due to the stage of disease at the time of diagnosis and the lack of effective therapies, euthanasia is often recommended when quality of life issues arise.

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