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OPHTHALMIC DISORDERS CAUSED BY DENTAL DISEASES IN DOGS

Jaqueline MOCANU[1], Iuliana IONAȘCU[1], Florin DUMITRESCU[1], Seralp UZUN[1]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest,
59 Mărăști Blvd, District 1, Bucharest, Romania

Corresponding author email: jacqueline_mocanu@yahoo.com

Abstract

Dental conditions such as tooth crown fracture, periodontitis or apical tooth root abscess in dogs can cause eye damage. Ophthalmological examination of patients from small dog breeds (Bichon, Yorkshire Terrier, Pomeranian) or brachycephalic dogs (Pug, Shih-tzu, Peckinez, French Bulldog) diagnosed with conjunctivitis, keratitis, corneal ulcer or uveitis must be completed with a dental examination. The information obtained through imaging (x-ray or CT) shows the degree of dental damage that can be one of the causes of the eye disease. The position of the roots of the 4th premolar in the dog and the maxillary molars near the incomplete orbit allows periodontal disease to develop orbital (retrobulbar) cellulitis. The therapy should primarily include treating the primary dental condition as quickly as possible to prevent secondary ocular complications (panophthalmia) that can lead to enucleation.

Key words*: eye, periodontitis, orbital cellulitis, dog.*

INTRODUCTION

Periodontal disease is one of the most common diseases in dogs. Diet, breed, age, lack of oral home care by the owner are factors that cause a simple gingivitis to slowly progress over time to periodontitis, and the inflammatory and infectious phenomena triggered by tartar plaque and microorganisms in the oral cavity damage the adjacent tissues. Periodontal disease affects the periodontium, the supporting structure of the tooth represented by the gingiva, alveolar ligament, dental alveolus (bone tissue). Periodontal disease is initiated by the biofilm formation, composed of a layer of glycoproteins derived from saliva that covers the surface of the tooth, followed by bacterial adhesion to this layer, resulting in a polymicrobial biofilm, also known as dental plaque. The microbiota of dental plaque is very complex and distinct depending on the stage of periodontitis. These bacteria infiltrate the subgingival space, produce metabolites such as ammonia and volatile sulfur compounds, which lead to halitosis, as well as bacterial endotoxins and proteolytic enzymes, which promote periodontal inflammation and activation of the animal's immune system. The persistent inflammatory response of the host against bacterial aggression of dental plaque leads to the progression of periodontitis (Cunha et al., 2022). Periodontal disease causes a series of local and general consequences on the animal's body. The local consequences refer to oronasal fistula, pathological fractures, ocular damage, osteomyelitis, increased incidence of oral cancer. Systemic consequences are represented by renal and cardiac damage (Niemec et al., 2020). In 80% of cases, in dogs, tartar plaque begins to form and develop on the tooth surface starting at the age of 2 years (Niemec et al., 2012). After ultrasonic scaling and professional dental brushing, dental plaque begins to form on the tooth after 24 hours; bacterial colonization and change in the oral microbiota is the cause of tartar plaque formation (Niemec et al., 2012). Dental fractures and caries by opening the pulp chamber through the apical and periradicular foramina create a communication path between the oral cavity and the structures located in the orbital cavity (the eyeball and the soft tissues around it) ultimately causing the appearance of retrobulbar cellulitis, uveitis, conjunctivitis, panophthalmia.

MATERIALS AND METHODS

Medical data of patients presented for surgical consultation in the clinic of the Faculty of Veterinary Medicine in Bucharest and the "Prof. Dr. Alin Bîrțoiu" University Veterinary Emergency Hospital during 2020-2024.

All patients underwent a complete clinical examination, ophthalmological examination, dental examination, radiological examination, computed tomography, biochemical blood test, blood count, general inhalatory anesthesia, dental surgical protocol of tooth extraction and scaling. Postoperatively, the patients remained hospitalized under medical supervision. Antibiotics, analgesics, anti-inflammatories were administered for 7-10 days. The animals were re-evaluated postoperatively at different time intervals.

RESULTS AND DISCUSSIONS

Naturally, the tooth is covered by a thin, invisible film called a biofilm formed by glycoproteins from saliva. Microorganisms (Gram-positive bacteria, Gram-negative bacteria, fungi) adhere to this biofilm and multiply rapidly, using substances resulting from the decomposition of food debris as an energy source (Kacirova et al., 2021). Colonized bacteria use adhesion and aggregation mechanisms to form dental plaque on tooth surfaces, which favors the development of periodontal diseases. Dental plaque is primarily composed of bacteria, fungi and glycoproteins produced by the salivary glands or due to bacterial caries. Aerobic Gram-positive and Gram-negative bacteria are the initial colonizers on the tooth surface. A common factor in periodontal disease is the increase in the population of *Porphyromonas gingivalis*, anaerobic and Gram-negative bacteria. The calcification of plaque creates tartar which, due to its porous surface, is ideal for the colonization and subsequent proliferation of pathogenic microorganisms. These microorganisms affect the periodontium and gingival connective tissue elements, leading to bone resorption and tooth loss (Alessandri et al., 2024; Cunha et al., 2020). Bacteria in subgingival plaque excrete toxins and metabolic products that create inflammation of the gingival and periodontal tissues (Holcombe et al., 2014; Verstraete et al., 2019). Periodontal disease is more common in small and toy breed dogs, as well as brachycephalic dogs such as: Bichon, Shi-Tzu, Pug, Carlin, mops, Peckinese, French Bulldog. In these dogs, due to the brachycephalic head conformation (the maxilla is shorter than the mandible), changes in the position of the teeth occur at the level of the premolars and upper molars, which causes the accumulation of food debris between the misaligned teeth. These food debris decompose under the influence of salivary enzymes and subsequently calcify under the action of mineral salts in saliva, forming, together with aerobic bacteria, anaerobic bacteria and desquamated cells from the gingival epithelium, dental tartar plaque.

Once the gingival pocket is infected, due to increased vascular permeability, proinflammatory white blood cells, polymorphonuclear neutrophils, and other inflammatory mediators migrate from the inflamed periodontal soft tissues. This process causes bacteria to migrate from the gingival sulcus into the general circulation with serious consequences for the entire body (Stepaniuk, 2014).

Retrobulbar disease refers to a pathological process originating in the retrobulbar space, namely the area located between the caudal portion of the eyeball and the posterior wall of the orbit (Perez et al., 2024; Winer et al., 2018). The development and progression of periodontal (Figure 1) and endodontic disease near the orbit, respectively the dental roots of the 4th premolar or upper molars in dogs can cause blindness (Zambori et al., 2012).

Figure 1. Periodontal disease in dogs. Gingival inflammation and recession show progression of infection to the tooth roots and deeper tissues (original Mocanu)

The proximity of the tooth root apices of the maxillary molars and fourth premolar, as well as the incomplete ventral orbit, places the retrobulbar tissues at risk (Shin et al., 2024). Extraction of these periodontitis-affected, fractured, or carious teeth resolves the retrobulbar infection (Verstraete et al., 2019).

Dental caries is also a pathology that causes apical abscess that develops secondary to periodontal disease through endodontics. Dental caries occurs more frequently on the occlusal surfaces of the fourth maxillary premolar, the first and second molars in dogs (Zambori et al., 2012). It is necessary to have a bacterial plaque that contains bacteria capable of surviving in the acidic environment caused by a diet rich in carbohydrates, and in turn to produce the acid necessary for enamel damage (streptococci and lactobacilli) (Kacirova et al., 2021). As the enamel is degraded, the bacteria enter the pulp chamber, the infection spreads to the tip of the tooth leading to the formation of a dental apical abscess (Stepaniuk et al., 2014) from here through the apical and periradicular foramina to the adjacent tissues.

The orbit is an incomplete bony structure composed of the frontal, lacrimal, maxillary, zygomatic, palatine, and sphenoid bones (Gioso et al., 2005). The zygomatic arch is formed rostrally by the zygomatic bone and caudally by the zygomatic process of the temporal bone (Dawson et al., 2015). The orbital ligament closes the orbit between the frontal process of the zygomatic bone and the zygomatic process of the frontal bone (Gioso et al., 2005). Inside it are the eyeball, adipose tissue, vessels, nerves, extrinsic muscles of the eyeball, lacrimal gland, zygomatic salivary glands (Perez et al., 2024).

The orbit contains a cone of structures associated with the eye called the periorbita, the apex of which is directed caudally. The periorbita is derived from the periosteum, contain the caudal portion of the eyeball and the extrinsic muscles of the eye, and is surrounded by adipose tissue. The orbit serves to position and protect the eyeball and houses the retrobulbar tissues (Verstraete et al., 2019).

The orbit borders medially with the nasal cavity, caudomedially with the skull, dorsomedial with the frontal sinuses, ventrally with the oral cavity, respectively the region of the maxillary bone occupied by the 4th maxillary premolar, the 1st and 2nd maxillary molars and, caudolaterally with the condylar process of the mandible. The apices of the 4th maxillary premolar and first and second molars (210) are in close proximity to the orbital floor, separated from the ventral orbital soft tissues by a thin layer of alveolar bone (Winer et al., 2018).

The fourth maxillary premolar is a large tooth with three roots, while the remaining molars have two roots. The roots of the premolars and molars are close to the infraorbital canal, nasal cavity, and orbit. The maxillary molars (209, 210) in the dog have a flat occlusal surface at the palatal level (Niemec, 2012).

Retrobulbar diseases can be classified into primary diseases (neoplasia, abscesses due to foreign bodies accidentally entering the retroorbital space from the oral cavity) (Dawson et al., 2015) and secondary inflammatory diseases caused by infectious processes of nearby structures, namely sinusitis, periodontal disease, endodontic abscesses as a result of dental pathology (caries, dental fracture, odontogenic cyst) (Perez et al., 2024).

The diagnosis of retrobulbar disease in dogs requires a multidisciplinary approach due to the complexity of the region and the adjacent structures involved. The clinical data obtained must be correlated with ocular ultrasound (Codreanu et al., 2022), radiological examination (Niemec et al., 2017), computed tomography (Dawson et al., 2015), and histopathological examination (Perez et al., 2024). Imaging examination facilitates detailed evaluation of the orbit, allowing clinicians to characterize, localize, and determine the extent of retrobulbar disease (Perez et al., 2024).

Figure 2. Skull radiograph, latero-lateral incidence; the outline of the exophthalmic eyeball is observed, the areas of intense radio-opacity given by the tartar plaque, radiotransparency in the area of maxillary bone lysis. Mixed breed, female, 12 years old (original Mocanu)

Clinical signs in case of retrobulbar abscess are: pain (trismus), manifested by resistance to opening the oral cavity during examination (the animal pulls its head) and ptyalism. Exophthalmia of the ipsilateral eyeball can sometimes be painful, accompanied by

chemosis and prolapse of the third eyelid. On examination of the oral cavity, a swelling can be identified in the pterygopalatine fossa. In some cases, maxillofacial edema occurs. The diagnosis is made based on clinical signs, ocular ultrasound, radiological examination (Figure 2) and computed tomography.

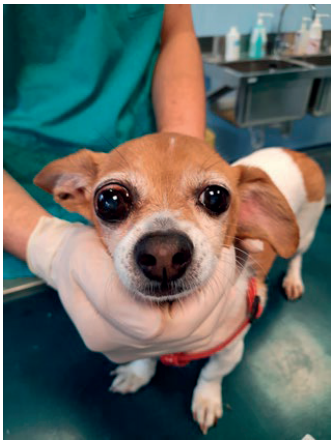

Figure 3. Unilateral exophtalmia secondary to retrobulbar abscess. Mixed breed, female 12 years old (original Mocanu)

Incision of the pterygopalatine fossa area is not recommended due to the vascular and nervous formations located here, namely the maxillary artery and vein, the maxillary nerve (middle branch of the trigeminal nerve) and the pterygopalatine parasympathetic ganglion (Stepaniuk et al., 2014).

In severe cases of periodontitis and/or patients with major systemic risk factors, systemic antimicrobial administration can be used to reduce the oral bacterial load and the risk of bacteremia (Cunha et al., 2020).

It is recommended to follow a systemic therapy based on antibiotics (metronidazole associated with ceftriaxone or metronidazole associated with spiramycin) (Kacirova et al., 2022), nonsteroidal anti-inflammatory drugs (robenacoxib) for 7 days, probiotics containing *Entrerococcus faecium*, followed by dental extraction, under general inhalatory anesthesia, of the affected teeth, ultrasonic scaling and professional brushing.

In the 12-year-old mixed-breed female with unilateral exophthalmos (Figure 3), the diagnosis following clinical ophthalmological and dental examination, supplemented by ocular ultrasound and radiological examination, was orbital cellulitis secondary to periodontal disease. Preoperative treatment with antibiotics and anti-inflammatories was administered.

Figure 4. Intraoral examination shows maxillary 4th premolar completely covered by tartar plaque (original Mocanu)

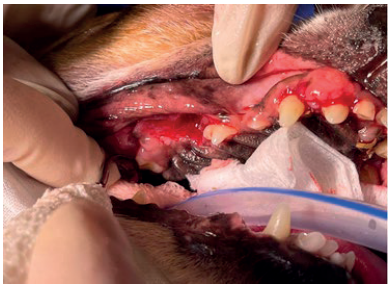

Figure 5. Tooth extraction of premolar 4 is completed with ultrasonic scaling and professional brushing (original Mocanu)

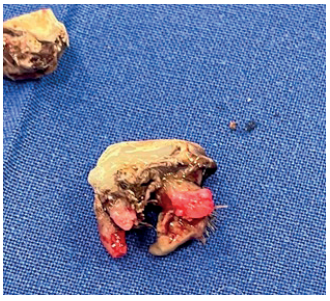

Figure 6. Maxillary 4th premolar after extraction (original Mocanu)

The tooth extraction was performed according to the dental surgical protocol (Figure 4, Figure 5, Figure 6). Regarding the effect of probiotics in the prophylaxis of periodontal disease, some authors suggest that they have a favorable implication in reducing the formation of dental tartar by reducing the number of bacteria in dental plaque (Sadighnia et al., 2023).

In some patients with ocular damage such as uveitis or glaucoma, the presence of periodontal disease was observed (Ionașcu, 2023).

Another form of ocular damage is anterior keratitis, i.e. the appearance of ulcerative corneal lesions on the corneal surface (Ionașcu, 2023), which appear 7-10 days after ultrasonic scaling, especially in dogs of brachycephalic breeds (French Bulldog, Pug, Carlin, Mops, Peckinese). These ulcerative corneal lesions manifested themselves unilaterally or bilaterally without having a traumatic cause or associated with keratitis sicca syndrome. Clinical signs of corneal ulcer in dogs are represented by blepharospasm, epiphora, conjunctivitis, mucopurulent ocular secretion, corneal edema, positive fluorescein test (Ionașcu, 2023). These corneal ulcers that occurred after ultrasonic dental scaling led the authors to consider as the cause exogenous contamination with bacteria originating from the tartar plaque remove from the oral cavity (Shin et al., 2024), created by the dispersion of aerosols generated by the device during ultrasonic dental scaling into the ambient air in the head region. As additional measures before starting the ultrasonic dental scaling procedure, we proceeded as follows: the patient under general inhalation anesthesia was positioned in the lateral position. After applying the corneal protective ophthalmic gel, the eyelids were closed, fixed with an adhesive tape, then the ocular area was covered with a generous layer of sterile gauze compresses, fixed with adhesive tape. At the end of the procedure, the gauze compresses and adhesive tapes were removed from the ocular area, and the corneal surface and conjunctiva were washed abundantly with sterile saline, then tobramycin eye drops were applied. Furthermore, brachycephalic patients were reviewed 14 days after scaling and evaluated ophthalmologically for ocular involvement. None of these patients had corneal involvement. The authors of this article observed that following modification of the intraoperative preparation protocol during ultrasonic dental scaling under general anesthesia in dogs, no cases of post-scaling corneal ocular involvement were reported.

Ultrasonic dental scaling is a professional periodontal procedure that aims to remove supragingival or subgingival dental plaque and tartar (Cunha et al., 2022).

CONCLUSIONS

Periodontal disease is one of the most common pathological conditions in dogs. Small brachycephalic dog breeds are the most affected. Oral malocclusion determined by dental misaligned causes the accumulation of tartar in the interdental spaces. Lack of home care oral hygiene through periodic brushing by the owner, supplements that clean dental tartar, a diet based on wet food are the prerequisites for the development of tartar plaque very early in the animal's life, and periodontal disease should no longer be the prerogative of geriatric patients.

From an evolutionary point of view, periodontal disease does not only affect the tooth and its supporting tissue, but the progression of the disease to the adjacent tissues causes their deterioration and the appearance of secondary pathologies. One of these pathologies is represented by ocular involvement in the form of orbital abscesses or if the inflammation caused by microorganisms from the dental plaque, has involved the eyeball, it manifests as uveitis, conjunctivitis, panophthalmia.

We recommend that all dogs with ocular involvement such as exophthalmos, uveitis, conjunctivitis, panophthalmia, and predisposed to periodontal disease be examined both ophthalmological and dental exam, and imaging (ultrasound, radiological) in order to establish a definitive diagnosis. The presence of periodontal disease can be one of the causes of ocular involvement, therefore, in these patients, we recommend dental extractions if necessary, ultrasonic scaling and brushing under general anesthesia.

Prevention of periodontal disease is achieved through home brushing by the owner with appropriate toothpastes, periodic professional scaling, additives added to drinking water, diets, dental care stick and chewing toys that, through the mechanical effect, prevent the formation of tartar.

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