Dental Disease in Animals

Dental disease is the most common condition that confronts veterinarians world-wide. It eventually affects the majority of animals, up to 80% of the most commonly kept mammalian pets, dogs, cats and rabbits, have dental problems by middle age and it is suspected that a similar number of horses and other farm animals are also affected. It causes bad breath, oral pain, behavioural changes such as reduced appetite, and may affect distant organs such as the kidneys, liver and heart. In addition to periodontal disease, many other abnormalities can affect the mouth and teeth. Good oral health is an important component of good general health for pets!

Owner awareness is increasing through client education programmes and the promotion of commercial products that have dental benefits leading to a growing demand for appropriate dental diagnosis and treatment. With the continuing progress in veterinary dentistry it is essential that practitioners enhance their knowledge and sharpen their skills in all aspects of dentistry, oral medicine and surgery. The European Veterinary Dental Society and the European Veterinary Dental College are both here to assist those involved in this field, whether as practitioners, researchers or teachers, making knowledge accessible to all and providing a framework for veterinary dental specialisation within Europe.

Production of this Dental Issue of EJCAP is the initiative of veterinary dentists who strongly believe that there is a need among general practitioners to extend their dental knowledge to the necessary level of competence. The required level should, in future, reduce the number of iatrogenic complications and mistakes currently occurring. There are two major directions to achieve this: education and investments. We hope this dental issue of EJCAP may provide a degree of education and inspiration for the investing and development of dentistry in each general practice in Europe. Reading this issue is just the first step forward. Further steps one can do together with EVDS, EVDC, ESAVS and other organisations.

Among many of the possible topics to be presented, we selected the ones which may provide reflections and make the reader think if dentistry is really present in her/his practice?

We want to acknowledge all the authors and sponsors for their contribution in this issue. In particular Dr Philippe Roux and his assistance should be noted as well as Prof Ellen Bjerkås, whose involvement in the scientific editing was invaluable. The group of dentists who contributed in the production represent the EVDS and the EVDC. It is appropriate to introduce those two associations to the readers.
The European Veterinary Dental Society is a non-profit making professional organisation which was founded in 1992 with the aim of promoting oro-dental care for animals by offering training to veterinarians and promoting research in animal dentistry. The membership has been maintained at around 200 since the society’s formation despite many new national dental societies and associations having been formed. Membership is open to veterinarians and other interested professionals, e.g. veterinary nurses, technicians and human dentists.

Membership includes subscription to the Journal of Veterinary Dentistry (published by the American Veterinary Dental Society) and the Society’s own publication, the EVDS Forum. Both publications provide clinical updates, contributions to scientific knowledge and information on upcoming events. Members are invited to join the EVDS email discussion group where information, questions and pictures can be exchanged. Whilst not intended as primary source of clinical information, it can also be used to obtain advice from other members on managing problem cases.

The need for practitioners to obtain the relevant information and skills is one of the primary concerns of the EVDS. To address this, the Society encourages the transfer of knowledge from those who have it, to the rest of the membership, by making it accessible through personal presentations, discussions at meetings and seminars, and publication of articles in the JVD or EVDS Forum.

Each year the EVDS organises a two-day meeting, the European Congress of Veterinary Dentistry. The programme typically includes scientific and clinical research presentations, review lectures, case reports, poster presentations, interactive sessions with at least one state of the art presentation by a keynote speaker and a number of social events. The congress is typically extended to include practical training sessions such as those presented by the EVDC and sometimes by joining up with a national meeting or conference. The initial meeting, the First European Veterinary Dental Congress, took place in Rome during September 1992 with subsequent meetings being held at various locations around Europe. More information on past, current and future meetings is available on the meetings page of www.evds.info.

The day to day business of running the EVDS is undertaken by the “board” (consisting of the president, president elect, immediate past president, treasurer and secretary. The board is elected by and reports to the membership at the annual business meeting which is usually held during the European Congress of Veterinary Dentistry. Current President of the EVDS is Dr Jan Schreyer Dipl EVDC (Germany), The rest of the Board comprises of: Dr Gottfried Morgenegg (Switzerland) - President Elect; Dr Pete Haseler (UK) - Honorary Treasurer; Dr Ines Ott (Germany) – Secretary; and Dr Jerzy Gawor (Poland) Past President.

The EVDC is a non-profit educational organisation formed in 1998 to advance veterinary dentistry through training and research, providing a structure for European veterinary specialisation in this field. Members of the EVDC are known as Diplomates and are veterinarians who have completed the EVDC credentialing and examination process following an extensive training programme in veterinary dentistry. Potential applicants for EVDC membership need to have undertaken an Approved Training Programme to ensure that they have a suitably broad range of knowledge and experience in the field of dentistry and oral surgery.

The EVDC collaborates with the EVDS in organising the annual “European Congress of Veterinary Dentistry.” To ensure high quality education for delegates, EVDC diplomates provide interactive sessions and practical training sessions during the congress. The EVDC also hosts mock exams and other sessions for individuals interested in or already working towards specialist status.

The EVDC is overseen by the European Board of Veterinary Specialisation which registers actively practising EVDC Diplomates as “European Veterinary Specialists in Dentistry.” To ensure that Diplomates maintain their specialist level of expertise, they are required to demonstrate their continued commitment to the speciality by documenting their activities in the speciality, i.e. clinical practise, teaching, authorship and research, every five years. Further information regarding the EVDC is available on their website: http://www.evdc.info/
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CHALKIDIKI - GREECE
The Importance of Dental Radiology

B.A. Niemiec(1)

INTRODUCTION

Dental radiology is quickly becoming the standard of care in veterinary dentistry. This is due not only to the fact that it is crucial for proper patient care, but also because of a significant increase in client expectations. Finally, providing dental radiographs as a routine service can create significant income for a veterinary practice.

This article will cover numerous pathologies for which dental radiographs are indicated. This will prove that dental radiographs are often critical for proper diagnosis and treatment of oral disease. These conditions should not be viewed as unusual; they are present within all of our practices. Not radiographing these teeth means leaving painful/infectious pathology behind.

Utilizing the knowledge gained from dental radiographs will not only improve patient care, it will also increase acceptance of treatment recommendations. Consequently, will lead to increased numbers of dental procedures performed at your practice. Finally, the information gained by via the radiographs should help smooth dental procedures.

Periodontal disease

Periodontal disease is by far the most common problem in small animal veterinary medicine. It has been reported that by the age of two, 70% of cats and 80% of dogs have some form of periodontal disease [1]. Therefore, the vast majority of veterinary patients have probing depths which are greater than normal.

Periodontal probing is an important first step in the evaluation of periodontal disease [2,3]. However, there are several reasons that dental radiographs should be obtained when evaluating periodontal disease.

1) First, periodontal pockets may be missed during probing due to narrow pocket width, a ledge of calculus (Fig. 1), or a tight interproximal space (Fig. 2) [4]. The latter condition is quite common in the molar teeth; especially in small and toy breed dogs. Dental radiographs may elucidate these pathologic pockets (Fig. 3).

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Fig. 1 Intraoral picture of the maxillary left canine (204) in a dog with periodontal disease. The ledge of calculus on the palatine surface may interfere with periodontal probing, resulting in missed pathology.
Dental radiographs are absolutely critical for proper dental care in feline patients [4,7]. This is because resorptive lesions, which are very common, require x-rays for diagnostic and therapeutic purposes. Since these lesions typically initiate at or below the gingival margin, clinical evidence does not appear until fairly late in the disease course (Fig. 6) [8]. Therefore, severe root and painful cervical crown resorption often occur undetected for long periods of time [4]. For this reason, many veterinary dentists recommend full mouth dental radiographs in all feline patients [9]. Recently, one study revealed that the mandibular third premolars (307 and 407) were typically the first teeth affected [10]. This has lead to the recommendation of starting with dental radiographs of these “sentinel” teeth in asymptomatic feline patients. If there is no clinical evidence of resorption to any tooth, and no radiographic signs on these teeth, no further radiographs are warranted. If there is any radiographic evidence of resorption, then a full mouth radiograph is recommended.

Feline Tooth Resorption (TR)

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Fig. 2 Intraoral picture of the interdental space of the mandibular right first and second molar (409-410) of a dog. The tight space does not allow for proper probing. This may also result in missed pathology.

Fig. 3 Intraoral parallel dental radiograph of the patient in Fig2: This demonstrates the tight contact between these teeth (white arrow). Note the significant periodontal loss between 409 and 410 (black arrow).

Fig. 4 Intraoral bisecting angle dental radiograph of the mandibular right in a dog. This radiograph reveals mild to moderate horizontal bone loss to the first and second premolars. This image will serve as a visual baseline for future radiographic studies.

Fig. 5 Intraoral parallel dental radiograph of the mandibular left in a dog. Note the severe periodontal loss resulting in 0.3 mm of remaining bone at the apex of the mesial root of the first molar (309) (arrow). This area is at significant risk for an iatrogenic pathologic fracture during the extraction attempt.
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resorption to these teeth or clinical evidence of resorption to any tooth, full mouth radiographs are recommended. However, this author has often noted significant resorption to only the mandibular canines and thus tends to expose full mouth dental radiographs in all feline patients.

Once a TR lesion is diagnosed, radiographs are critical to making appropriate therapeutic decisions [7]. There are two recognized types of TRs (1 and 2) [7,11]. Type 2 lesions demonstrate significant replacement resorption of the roots which makes extraction very difficult [11]. Resorption in these cases typically continues until no recognizable tooth structure remains (Fig. 7). In these cases, endodontic infection does not occur [12]. This finding has resulted in the accepted therapy of crown amputation for treating these teeth [13]. Remember, ONLY if there is significant ankylosis and root resorption (no evidence of periodontal ligaments or endodontic system), is crown amputation and intentional root retention an acceptable method of therapy [13]. In addition, patients with caudal stomatitis should not receive crown amputation [7].

Fig. 6 b Intraoral dental radiograph of the tooth in Fig 7. Note the severe tooth resorption (TR) affecting this tooth at the gingival margin without obvious clinical signs (arrows). Findings like this support full mouth radiology in all feline patients.

Fig. 7 Intraoral bisecting angle dental radiograph of a mandibular left third premolar (307) in a cat. This tooth is affected by a SEVERE type 2 TR lesion. Note the severe tooth resorption and ankylosis affecting this tooth making complete extraction difficult to impossible. Crown amputation is an acceptable treatment in this case.

Fig. 8 Intraoral parallel radiograph of the mandibular left premolars and M1 in a cat. All three teeth are affected by a significant tooth resorption. There is normal root structure remaining, however, which makes complete extraction necessary to resolve the pain and infection.

Fig 9: Mandibular left of a cat. Severe type 1 TR to the first molar (309) with periapical rarefaction to the mesial root.
There are no reliable clinical signs that accurately differentiate between type 1 and type 2 lesions [4]. In addition, the degree of replacement resorption cannot be determined without dental radiographs. Therefore, without the knowledge provided by dental radiographs crown amputation therapy should NOT be performed.

Tooth Resorption in dogs

While not as common as resorptive lesions in cats, dogs do develop resorptive lesions [4,7]. This is more common in older dogs [14]. In most cases, it is the mandibular premolar teeth which are involved (Fig. 11). In addition to the resorption, these teeth often have concurrent periodontal disease. The resorption and secondary ankylosis makes extraction by traditional means difficult to impossible [7], thus necessitating a surgical approach [4]. Knowing the condition of the roots prior to initiating surgery will help in several ways [4]. First, it allows for a proper time estimate as well as fee schedule. Furthermore, by performing a surgical approach from the beginning, the surgeon can follow the roots during the buccal bone removal, rather than searching for fractured roots. Finally, pre-surgical knowledge of the ankylosis will caution the practitioner, decreasing the chances of an iatrogenic pathologic fracture.

Endodontic (root canal) disease

Endodontic disease is also very common in veterinary dentistry. It has been shown in one published report that 10% of all dogs have at least one tooth with direct pulp exposure! [15] Unfortunately, animal patients with endodontic disease will typically suffer for a long time prior to diagnosis and definitive treatment. Therefore, the vast majority of endodontic cases go undiagnosed due to the lack of outward signs of disease other than a broken or discolored tooth. This is because cats and dogs very rarely show any obvious signs of oral pain or the disease process [16].

In contrast, type 1 TRs do not undergo replacement resorption [11]. These teeth generally retain sufficient normal root and pulp structure to result in pain and infection. If the dental radiograph reveals intact root structure (Fig. 8) or worse yet an active infection (endodontic (Fig. 9) or periodontal (Fig. 10)) then complete extraction of the root is mandated [7,13]. Extraction of these teeth often requires a surgical approach to achieve complete removal due to the resorption [4].

Armed with a diagnostic dental radiograph, the surgeon can save time by directing his or her efforts appropriately rather than delving after retained/ankylosed roots. Radiographs will also allow the practitioner to more accurately estimate the surgical time and cost of the procedure.

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In cases of obvious endodontic compromise such as a complicated crown fracture (Fig. 12) or intrinsic staining (SI) (Fig. 13), radiographs may sway the reluctant client into allowing therapy (Fig. 14). However, dental radiographs are even more critical in cases where endodontic disease has either subtle or no clinical signs.

The most common instance of camouflaged endodontic disease is an uncomplicated crown fracture, where dentin but not the pulp is exposed (Fig. 15). In the majority of cases, these teeth are vital; however there is a possibility that the endodontic system has been infected through the dentinal tubules [7]. This can result in tooth non-vitality and infection/abscessation just like a tooth with direct pulp exposure. This painful infection cannot be diagnosed without dental radiographs [4]. Therefore, every

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Tooth with direct dentin exposure should be radiographed to rule out endodontic disease. Further therapy is always indicated, depending on the results of the dental radiograph. If the dental radiographs reveal no signs of endodontic disease, a bonded sealant should be performed to seal off the tooth from infection and to decrease sensitivity [7]. The patient should have dental radiographs repeated in 9 months to ensure the tooth is/was not sub clinically infected [7]. If there is evidence of tooth death (wide root canals (Fig. 16) or periapical lucency (Fig. 17), root canal therapy or extraction is mandated [7].

Another common scenario in which teeth appear healthy but may be endodontically involved is with worn (attrition/abrasion) teeth [4]. If a tooth has been worn to the point of direct pulp exposure (Fig. 18), it is an obvious case of endodontic disease and requires either root canal therapy or extraction. If there is adequate reparative (tertiary) dentin in the pulp chamber (Fig. 19), the vast majority of these teeth remain vital and pain free [18].
With no clinical or radiographic evidence of endodontic disease, a bonded sealant may be indicated and recheck radiographs in 9 months are recommended. It is critical to note however, that there are teeth which will are non-vital and infected in spite of visibly sufficient reparative dentin [18]. These cases can only be elucidated by dental radiographs. If radiographic evidence of endodontic disease is present (i.e. wide root canals or periapical lucency) (See images 16 and 17), again, root canal therapy or extraction is indicated [4-7, 18].

The final scenario of camouflaged endodontic disease are clinically normal teeth (Fig. 20), which are actually infected [4]. It is important to remember that infected rarely present with clinical abscessation, making diagnosis without dental radiographs impossible. The result is countless patients being chronically affected with painful/infected teeth. Not only will dental radiographs diagnose the abscess as a dental problem, it will also elucidate which tooth is causing the infection. These cases (as well as many others) prove the value of full mouth radiographs for all veterinary patients [9,19].

**Persistent deciduous teeth (previously called retained)**

Extraction of persistent deciduous teeth (Fig. 21) is a very common procedure performed in veterinary dentistry. However, without dental radiographs this can be a very difficult and frustrating endeavor. If a deciduous tooth fractures, does it need to be surgically extracted or will it resorb on its own? Unfortunately, without the benefit of dental radiographs, this question cannot be answered.

In some cases, the root of the deciduous tooth is normal and is held in naturally by the periodontal ligament (Fig. 22). In these cases, extraction is straightforward and root fracture should not occur if the extraction is performed correctly. In most cases however, the deciduous teeth will have undergone some to significant resorption due to the pressure placed on the deciduous tooth by the erupting permanent dentition [4]. These teeth may also be resorbing or ankylosed, but an intact root canal is often still present (Fig. 23). The resorption and ankylosis makes extraction very difficult and will commonly result in a fractured root. In these cases, as in resorptive lesions above, a surgical approach from the beginning may be prudent. Regardless, if there is an identifiable root canal, these roots require complete extraction to avoid inflammation and infection [20,21].

Finally, there are occasional cases where the root structure of the deciduous tooth has been completely resorbed and the crown is only being held in by ankylosis at the alveolar crest (Fig. 24) [21]. Proper therapy for this requires that only the crown and the very small retaining root segment be removed. By knowing this from the start, the practitioner saves time by not looking for...
“Missing” Teeth

It is exceedingly common for teeth to be absent in the dental arcades of veterinary patients (Fig. 25). In some cases the tooth is truly missing, however in others, the tooth/root is present and may be pathologic. Do not assume that the tooth is not present just because it is missing or previously extracted if radiographs have not been taken of the area.

Possible etiologies for “missing” teeth include [21]:

1. Congenitally missing (Hypo or Oligodontia) [22]: This is generally considered to be a genetic problem, but can be secondary to significant in utero or neonatal issues. This condition is common in small, toy, and brachycephalic breeds [23]. In addition, there is a genetic predisposition in Chinese Crested and Mexican Hairless breeds [21]. The premolars, maxillary second and mandibular third molars, and then incisors are the typical teeth to be absent. No specific therapy is necessary.

2. Previously exfoliated (lost): This is very rare in the juvenile patient, but quite common in mature to geriatric animals. This occurs most commonly due to periodontal disease, but can also happen secondary to trauma. The main cause, however, for this condition is previous extraction (which should be in the patient’s record). In these cases, radiographs will usually reveal evidence of a healing alveolus. Again, no specific therapy is necessary.

3. Fractured below the gingival margin (Fig. 26): This condition is also rare in the juvenile patient, but common in adults. This condition may also result from an incomplete extraction attempt, as retained roots are far more common than most people believe. Dental radiographs will confirm a retained
root and quite possibly an infectious lesion. If the root appears relatively normal (i.e. not being resorbed), surgical extraction is generally the recommended course of action to alleviate pain and endodontic infection.

4. Impacted or embedded (Fig. 27): These teeth can be malformed or normal, but do not erupt into the dentition because they are blocked by a structure such as bone or tooth (deciduous or permanent); or most commonly by an area of thick and firm gingiva called an operculum. This condition is most common in the first and second premolars of brachycephalic breeds. However, any tooth can be embedded.

The biggest concern with unerupted or impacted teeth is the development of dentigerous cysts. These arise from the enamel forming organ of the unerupted tooth. The incidence of this is unknown in veterinary medicine; however anecdotally is approximately 50%. In addition, pathologic changes were noted in 32.9% of cases in one human study [24]. As the cyst grows it will cause bone loss by pressure. These cysts can grow quite large in a short period of time, thus resulting in weakened bone (Fig. 28). This will necessitate a large surgery or may cause a pathologic fracture. In addition, they can become infected and create significant swelling and pain. Finally, malignant transformation has occurred in these cases [25]. Therapy for impacted teeth is surgical extraction. If cystic formation has occurred, en bloc removal or extraction of the tooth and meticulous curettage of the lining will prove curative.

Fig. 28 Intraoral bisecting angle dental radiograph of the mandibular canine region in a 2 year old dog. Both mandibular canines were “missing”. Note the impacted tooth (white arrows) and large cystic formation (red arrows). Intervention (surgical extraction and cystic debridement) is indicated. Finally note that the ventral cortex is significantly weakened in the areas of the cyst (blue arrow). If cases like this are missed, a pathologic fracture could eventually result. Findings like this support obtaining dental radiographs for all missing teeth.

It is critical to note that two of the causes for “missing” teeth require no therapy and the other two can lead to significant pathology. Therefore, all “missing” teeth should be radiographed to ensure that they are truly missing.

**Mandibular fractures**

Mandibular fractures are a fairly common occurrence in veterinary medicine. They are generally traumatic in nature, however in our aging patients there is an emerging problem known as a pathologic fracture.

Chronic periodontal loss will loosen the tooth support and result in exfoliation.2 In the majority of teeth, this will occur prior to severe bone weakening. However, in some situations significant bone thinning will occur prior to tooth exfoliation. Pathologic fractures are most common in small breed dogs [2,5] for several reasons:

1) Small and toy breed dogs appear to have a genetic propensity to severe periodontal disease.

2) They tend to live longer.

3) Most importantly, they have proportionally larger teeth than do larger breeds. This results in the root apex of the mandibular first molar being very close to the ventral cortex of the mandible (Fig. 29). The next most common place for this is the mandibular canines. These teeth comprise 60-70% of the strength of the rostral mandible (Fig. 30) [4]. Thus the jaw will weaken to the point of fracture before the tooth exfoliates.

Fig. 29 Intraoral parallel dental radiograph of the mandibular right first molar (409) in a small breed dog. Note that the apex of the mesial root is within a few mm of the ventral cortex (arrow). Chronic periodontitis in this area will predispose the patient to a pathologic mandibular fracture. In addition, the mesial root is highly curved which would complicate extraction. Finally, note that this patient DOES have significant periodontal loss at this time.

Fig. 30 Intraoral bisecting angle dental radiograph of the mandibular canines (304, 404) in a cat. Note that the apices of the roots are within a few mm of the ventral cortex (arrows). Chronic periodontitis in this area would predispose the patient to a pathologic fracture.
Fig. 31 Intraoral parallel radiograph of the mandibular left fourth premolar and first molar (308 and 309). Periodontal disease has weakened the area of the mesial root of 409 (black arrow) resulting in a mandibular fracture (white arrow).

Fig. 32 Recheck intraoral parallel dental radiograph of the mandibular right first molar (409) in a small breed dog. This patient was presented for a non-healing fracture which had been treated with a bone plate. The radiograph confirms that the fracture is pathologic, and healing cannot occur until the infected tooth roots are removed.

Fig. 33 Intraoral bisecting angle dental radiograph of the maxillary left third premolar (207) in a dog. Note the supranummary palatine root (arrow). Knowledge of this extra root will help avoid tooth fracture during extraction and greatly facilitate the surgery. In addition, it will help avoid leaving a painful, retained root behind.

Fig. 34 Intraoral bisecting angle dental radiograph of the mandibular canines (304 and 404) in a cat affected with advanced type 2 lesions. The lack of a definable periodontal ligament space is indicative of severe dentoalveolar ankylosis. This will make conventional extraction impossible. In addition, aggressive surgical technique could easily lead to an iatrogenic mandibular fracture.

Pathologic fractures typically occur due to mild trauma (jumping off a bed) or during extraction procedures, however some dogs have broken their jaw while eating [5]. Although this is typically thought of as a disease of older patients, this author has personally treated 3 cases in which the dogs have been three years of age or less. In addition, there was one reported case of a 1.5 year old dog having a pathologic fracture.

A pathologic fracture should be suspected in any case of a mandibular fracture, especially in the area of the mandibular first molar or canine of older toy breed dogs. Additional supportive history is lack of obvious trauma, a non or mildly painful patient, periodontal disease elsewhere in the mouth, and lack of response to adequate fixation.

Diagnosis of a pathologic fracture is only possible with dental radiographs as skull films typically provide insufficient detail. The classic appearance of a pathologic fracture is bone loss around the tooth and/or periapical lucency in the area of the fracture or other root of a multirooted tooth (Fig. 31) [4]. The fracture will not heal no matter how perfect the fixation is if the diseased tooth root is not extracted (Fig. 32) [26]. This is due to the fact that the tooth will act as a nidus of infection and not allow healing to occur.

Extractions

Pre and post-operative dental radiographs should be exposed for all extraction procedures [4]. Pre-extraction x-rays allow the practitioner to determine the amount of disease present, any root abnormalities (curved (Fig. 29), supranummary (Fig. 33), ankylosis (Fig. 34)). Fully 10% of maxillary third premolars in cats have a third root [27]. In addition, the level of remaining bone will be elucidated (see periodontal disease above). In the case of a mandibular first molar or canine extraction, knowing the amount of remaining mandibular bone can be critical to avoid a pathologic fracture [5]. Finally, the radiographs will serve as legal evidence of the need for extraction.

Post-extraction dental radiographs are equally important. Regardless of the appearance of complete extraction, there is still a possibility of retained roots or other pathology, making
post-operative radiographs critical in all cases (Fig. 35). Finally, they will also serve as a legal document in cases of complications.

**Conclusion**

Considering that nearly every veterinary patient has some form of oral disease and that dental radiographs are indicated for all oral disease, virtually all patients will benefit from the information provided by dental radiographs. In addition, dental radiographs are a critical piece of information for the veterinarian when treating oral disease. Therefore, dental x-ray equipment should be used on a daily basis in every general practice.

From a financial standpoint, there is not a piece of veterinary equipment that has the potential to provide the return on investment that a dental radiology machine does. If a moderately busy practice exposed radiographs whenever necessary, this equipment should be paid for in less than three months. This does not include the income from the additional procedures that could now be performed with confidence such as composite bonding, root planning and scaling, extractions, and periodontal surgery. Nor does it factor in the significant time savings during oral surgery. The information provided by radiographs regarding root and bone pathology, as well as documenting complete extraction, is crucial. Furthermore, the time savings during extractions is incalculable. And finally, dental radiographs will provide peace of mind to the clinician, which is priceless.

**References**


Fractured teeth are a relatively common finding in dogs and cats. The teeth most frequently involved are the canines, carnassials and incisors. Tooth fractures result from trauma, such as traffic accidents, falling off buildings (high rise syndrome), biting on hard objects like bone, stones or metal or being hit accidentally. Although a tooth fracture is an acute injury, it will often go unnoticed by the owner for a long time because dogs and cats will not show the pain they certainly have when the pulp is exposed or inflamed. All fractured teeth need a thorough diagnostic approach and almost all need some kind of treatment. The “wait and see” approach is not an option in these cases.

**INTRODUCTION**

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**Diagnosis**

The first step to diagnose a tooth fracture is a conscious examination of the oral cavity. Findings suspicious of a tooth fracture are an abnormal contour or discoloration of a tooth (Fig. 1), an exposed pulp (Fig. 2), and mobile or missing teeth (Fig. 3) [1].

If a tooth fracture is confirmed or suspected during the conscious examination, a complete diagnosis for this tooth needs to be established. This will require a deep sedation or anaesthesia of the patient [2].

Under anaesthesia the extent of the fracture needs to be confirmed by using a sharp dental explorer to palpate the edges of the fracture, to search for a pulp exposure and for fissures in the remaining part of the tooth. Also an intraoral dental radiographic examination of the tooth and the surrounding tissues is mandatory [1] [2].

With the help of these diagnostic techniques together with the case history a number of questions need to be answered to obtain a complete diagnosis and to be able to plan an appropriate treatment [3].

1. Are there any other problems with this tooth? If there are additional problems with the tooth, e.g. advanced periodontitis, it is questionable if it makes sense to perform any kind of restorative treatment.
2. **Is it a “strategic” tooth?**
Canine and carnassial teeth are functionally important teeth, whereas smaller teeth are less important functionally, but may be important to the owner for cosmetic or breeding reasons.

3. **What caused the tooth fracture?**
The restoration of a fractured tooth will carry a good prognosis only in cases, where the cause of the fracture can be avoided in the future.

4. **How much tooth substance has been lost?**
Loss of small pieces of enamel can be easily restored with a good prognosis, whereas the loss of larger parts of the crown will be far more challenging to treat.

5. **Is the root affected?**
Teeth with root fractures are best treated by extraction in most cases.

6. **Is the pulp exposed or otherwise damaged?**
All cases with an exposed or non-vital pulp need additional treatment of the pulp prior to restoration or extraction. A damaged pulp must not be left untreated!
Fractures not exposing the pulp are named uncomplicated fractures, whereas any pulp exposure converts them into a complicated fracture.

7. **How old is the animal?**
The teeth of young animals may have not fully matured. These teeth need a specific treatment.

8. **How long ago did the fracture occur?**
An exposed pulp will always lead to infection and subsequent death of the pulp, but even without direct pulp exposure bacteria can still invade the pulp through the exposed dentinal tubules and lead to pulp infection.

There are some differential diagnoses, which need to be distinguished from tooth fractures [1,3]. These are:

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### Differential Diagnoses:

1. **Attrition or abrasion of teeth**
   Attrition is the loss of tooth substance due to an abnormal occlusion. Abrasion is the wear of tooth substance due to normal, excessive or ill-advised chewing or play activities (food, toys, bone, stones) or abnormal behavior (cage chewing).

2. **Abnormalities of enamel formation (enamel hypoplasia and enamel hypomineralisation)**

3. **Caries lesions**
The cause of these lesions is dental decay due to bacterial activity.

4. **Tooth resorption**
This loss of tooth substance is caused by the resorptive activity of odontoclastic cells.

For clinical use, the tooth fracture classification scheme developed by the American Veterinary Dental College is most useful. Besides enamel infraction, which refers to incomplete fractures (cracks) of the enamel without loss of tooth substance, and which normally does not need treatment, it lists the following classes of tooth fractures [4]:

1. **Enamel fracture (EF):** A fracture with loss of crown substance confined to the enamel (Fig. 4).

2. **Uncomplicated crown fracture (UCF):** A fracture of the crown that does not expose the pulp (Fig. 5).

3. **Complicated crown fracture (CCF):** A fracture of the crown that exposes the pulp (Fig. 6).

4. **Uncomplicated crown-root fracture (UCRF):** A fracture of the crown and root that does not expose the pulp (Fig. 7).

5. **Complicated crown-root fracture (CCRF):** A fracture of the crown and root that exposes the pulp (Fig. 8).

6. **Root fracture (RF):** A fracture involving the root (Fig. 9).

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**Fig. 2 Fractured upper canine tooth with an exposed and necrotic pulp.**

**Fig. 3 Fractured lower P4 represented as a missing tooth, the fractured root remnants prevent healing.**
After having obtained all the information described above, an appropriate treatment plan needs to be established. All possibilities and the relative costs of the treatment options need to be explained to and discussed with the owners in order to choose a treatment option, which is adequate to solve the problem and is also acceptable and supported by the owner [3].

The first question to be answered is, can the fractured tooth be saved or does it need to be extracted? There are some indications that make conservative treatment unfeasible or unreasonable. Significant periodontal disease of the fractured tooth or significant root damage will necessitate the extraction of the tooth. Also the loss of so much tooth substance, that the remaining crown will not have any function anymore should lead to the decision to extract this tooth [1,3].

Fractures of deciduous teeth also need treatment! Sometimes a practitioner will express the opinion that fractured milk teeth need no treatment, since they will be shed soon. But this is wrong. Deciduous teeth have a pulp, which will become infected in case of a complicated fracture. This infection, and the
subsequent death of the pulp together with the spread of the
infection to the tissues surrounding the apex of the tooth, will
prevent the root from becoming resorbed. This will prevent the
tooth from falling out normally. The infection can also damage
the developing tooth bud of the permanent tooth, which is
located in close proximity to the apex of the milk tooth. This is
why fractured deciduous teeth need treatment, which in most
cases will be extraction of the tooth (Fig. 10) [5].

Extraction is also a valid treatment option for every other
fractured tooth in cases where the owner does not wish to use
a conservative treatment. It will solve the problems associated
with the tooth fracture and will avoid pain and infection of the
tooth and jaw, which will occur eventually with every tooth
fracture at some point in time.

If the owners decide to save the tooth, the treatment options
depend mainly on the extent of the fracture (see fracture
classification), whether the pulp is exposed and whether the
tooth is mature or immature.

Enamel fractures and uncomplicated crown fractures that do not
show any signs of pulp involvement, will only need a smoothing
of the sharp enamel edges and a sealing of the exposed dentin
tubules [3]. For better mechanical protection, restoration with
an appropriate restorative material (e.g. composite or glass-
ionomer) can be performed [1]. If the fracture extends close to
the pulp cavity (near-pulpal exposure) an indirect pulp capping
needs to be performed to protect the pulp. To achieve this, a
base layer of calcium hydroxide, zinc oxide eugenol or glass
ionomer cement is placed over the near exposure site, and
under the final restoration. Since a possible infection of the
pulp will take some time to become visible radiographically by
the development of a periapical lesion, it is recommended to
perform a radiographic recheck examination 6-9 months after
this treatment. Ideally these rechecks should be repeated every
6-9 months for 3 years [6].

For uncomplicated crown-root fractures the treatment depends
on the extent of the fracture line down the root. If the extent is
not too deep, the fracture can be treated as described above but
the owner will be required to establish effective dental home
care to preserve periodontal health at the point the fracture
extends below the gingival margin. If this fails, a gingivoplasty
with or without additional osteoplasty may be performed to
improve periodontal health. If the fracture extends deeper
down the root, extraction is the treatment of choice.

In complicated crown fractures, the damaged pulp needs
to be treated before any kind of restorative treatment can
be performed. The treatment of the injured pulp is called
endodontic treatment [1,6].

If the tooth is mature, which means that the apex is closed
(radiographically confirmed), a standard (nonsurgical) root
canal therapy needs to be performed regardless of whether
the pulp is still vital or not [6]. The only exception to this are
fractures where the pulp is vital, and the exposure is confirmed
to be less than 48 hours old [7,8]. In these cases a direct pulp
capping procedure can be performed, as described later in this
text. Standard root canal therapy is a highly effective means of
controlling the pain and infection associated with endodontic
disease while retaining the function of the tooth. It consists
of three consecutive steps which are the creation of a suitable
access to the pulp chamber, the removal of the damaged
pulp followed by the cleaning, shaping and sterilization of the
root canal, and finally the tight obturation of the whole pulp
system (Fig. 11). Techniques to achieve this are described in the
literature [1,6-9]. This procedure is very technique sensitive and
needs some practice to be performed perfectly, but if done
properly it carries a very good prognosis. Also these cases need
a radiographic recheck in the same intervals already described
[6]. If periapical pathology persists or occurs later, despite the

Fig. 10 Fractured deciduous canine tooth with fistulation at the
location of the root apex.

Fig. 11 Radiograph of endodontic obturation of a fractured upper
first incisor, note the tight filling of the complete endodontic
system.
endodontic treatment being radiographically successful at the time, a surgical endodontic procedure (Apicectomy), with resection of the infected root tip and retrograde filling, needs to be performed in order to save the tooth [10,11].

The same treatment is performed for complicated crown-root fractures, if the fracture extents not too deeply, as already described for uncomplicated crown-root fractures. If the fracture extents deep down the root, the tooth needs to be extracted (Fig.12).

In immature teeth a standard root canal therapy is not possible, since these teeth have an open apex and thin dentinal walls, which makes it impossible to fill them tightly. If the pulp is still vital, and there are no radiographic signs for periapical disease at the time of presentation regardless of the duration of exposure, the goal of endodontic treatment of these teeth is to keep them vital for as long as possible. Although the procedure generally fails long term, almost all teeth treated in this manner survive long enough to achieve apexogenesis (closure of the apex) and sufficient maturation of the dentinal walls to allow a standard root canal treatment later on. The procedure performed in these cases is called direct pulp capping. It can also be performed in mature teeth with vital pulps and exposure time less than 48 hours. However the failure rate with mature teeth is relatively high, at 11.8%, and this is why a standard root canal treatment should be performed in these teeth [7,8,12].

To perform a direct pulp capping the first step is to remove all diseased pulp, and make room for the materials used to seal the tooth (generally 5-7 mm). After that the hemorrhage is controlled with dampened sterile paper points or cotton pellets. The first layer placed as pulp dressing is calcium hydroxide or mineral trioxide aggregate. Both materials stimulate the remaining odontoblasts of the pulp to produce tertiary and/or reparative dentin to protect the pulp. This becomes radiographically visible on rechecks in some cases as a "dentinal bridge" below the filling (Fig. 13). The second layer of the filling is an intermediate layer, which protects against further bacterial contamination and works as a base for the final restoration. A glass ionomer is generally chosen for this purpose. The last step is the restoration of the access hole with a suitable restorative material. These cases need radiographic rechecks over a period of at least 3 years because of the common finding of a vital tooth at 6 and 18 month radiographic follow ups, but a non-vital tooth at 3 years recheck [6,10-12].

If an animal is presented with a fractured immature tooth with a necrotic or irreversibly inflamed pulp, and the owner wishes to save the tooth, the only possible procedure is apexification. This means, that all remaining pulpal tissue is removed from the root canal and the root canal is cleaned. After that the whole root canal is filled with calcium hydroxide, which will activate osteoblasts and possibly surviving odontoblasts in the area of the open apex. These cells should eventually form a barrier of hard tissues closing the apex. This will make a subsequent standard root canal treatment possible. Since the calcium hydroxide will lose its activity with time, it is recommended to change the filling every 4-6 weeks, until closure of the apex is radiographically visible [1,11]. The use of mineral trioxide aggregate instead of calcium hydroxide is also possible during this procedure [13].

All endodontic treatment options need a thorough knowledge and a lot of training to be performed perfectly, since all these procedures are highly technique sensitive. If not performed absolutely perfectly, the endodontic therapy is likely to fail and the patient is no better off than if nothing was done. Perfection is paramount and necessitates that the practitioner spend hours in laboratories as well as practicing on cadavers or extracted teeth perfecting skills before treating an actual patient [6].

Every tooth fracture weakens the tooth. To protect teeth from further breakdown, especially in working dogs or animals with abnormal habits like cage biting, a prosthetic crown can be placed [3,14].
All of the above mentioned treatment modalities show that a thorough and complete diagnosis needs to be established to be able to choose the correct treatment for fractured teeth. A diagram to help finding the right treatment option is shown above.

References

Periodontal Disease from the whole Body Perspective

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Periodontal disease - chronic wound in the oral cavity

The oral cavity harbours hundreds of bacterial species; it has been suggested that 700 species can colonize the subgingival biofilm [1]. Periodontal disease is the most common chronic infection in dogs and humans, affecting tooth supporting tissues and leading to tooth loss [2-4]. Although periodontal disease is primarily an infectious disease, the disease progression is determined by (the loss of) the complex equilibrium between bacteria and the host response [5]. The surface area of periodontal wound (the inflamed pocket lining which is adjacent to the site of bacterial growth) in the oral cavity of humans with periodontal disease can measure between 8 and 200 cm² [3], where in small dogs (poodles) it has been determined to measure 3,18 to 29,8 cm² [4] (Fig. 1).

Focal infection

The term “focal infection” was introduced 100 years ago [6] and it indicates a chronic, localized infection, which is a potential source of microorganisms and/or their products/toxins to influence distant tissues/organisms. Periodontal disease is a focal infection, with bacteria and/or their products/toxins entering the systemic circulation from the oral cavity during mastication or even routine oral home care; this likely causes bacteraemia/endotoxaemia, although no association between endotoxin activity in serum and severity of periodontitis was found in a recent study in humans [7]. Bacteria and their products/toxins are also constantly aspirated and swallowed. Periodontal disease as a focal infection has gained more attention recently, with most reports coming from human medicine focusing on the association between systemic diseases and periodontal disease [2, 5, 8]. The common denominator of the multiple biological pathways proposed to form the basis of this association is the chronic state of systemic inflammation that accompanies severe periodontitis, characterized by elevated acute phase proteins such as C-reactive protein (CRP), pro-inflammatory cytokines such as interleukin (IL)-6 and coagulation factors such as fibrinogen [9], which can also be observed in patients with gingivitis only [10]. However, there is speculation that a common underlying hyper-inflammatory phenotype might predispose people, both to periodontitis and systemic inflammation [11]. These bidirectional effects mean that elevated levels of inflammatory biomarkers may signify both the causes and consequences of periodontitis [12].

Cardiovascular diseases

Epidemiological studies have shown that patients with periodontitis are at significantly increased risk of developing cardiovascular disease [13]. Gram-negative bacteria or their lipopolysaccharides are reported to induce atherosclerosis-like lesions in experimental animals, and similar data comes from human clinical studies, where traces of periodonto-pathogenic bacteria were detected in atherosclerotic plaques [3]. Although bacteraemia in periodontal disease patients is suggested to be a passive event, some periodonto-pathogenic bacteria can actively
spread and enter endothelial cells [2-3]. Bacterial endocarditis is also reported to be a possible sequel of bacterial spread from the oral cavity [2]. In dogs, periodontal disease has been described in association with aortoventricular valve disease [4] and myocardial disease [14]. Severe anaemia of chronic disease has also been reported in a human with periodontitis [15]. Not only bacteria, but also infection-associated increased systemic levels of pro-inflammatory cytokines, and systemic (nitr)oxidative stress in periodontal disease patients are likely involved in the development of cardiovascular disease [2-3, 13, 16-19].

Respiratory diseases

Aspiration pneumonia can develop when oral bacteria and/or their products/toxins are inhaled [8]. Poor oral health, especially if the periodonto-pathogenic bacterium Porphyromonas gingivalis is present in the oral cavity, has been described to increase risk for aspiration pneumonia. This might be related to the immunomodulatory effect of some periodonto-pathogenic bacteria, leading to increased susceptibility for bacterial tissue colonisation and infection [8, 20]. Aspiration pneumonia caused by inoculation of experimental animals with dead or alive P. gingivalis also increases systemic pro-inflammatory cytokine levels that may affect distant tissues and organs [21-23]. However, it seems that aspiration and/or ingestion of P. gingivalis inhibits systemic immune response in the very early phases of infection as determined by systemic nitric oxide levels [24]. Nitric oxide having an important protective role in P. gingivalis infections [25], its reduced levels might indicate a transient tolerance of the host to the presence of P. gingivalis, which enables survival of the bacterium and greater colonisation of tissues [20].

Reproductive disorders

It has been established that women affected with periodontal disease are at 7.5-times higher risk to have preterm delivery and/or deliver babies with low birth weight. This is likely associated with lipopolysaccharides circulating in the bloodstream and subsequent increase in pro-inflammatory cytokines [2-3, 8]. Periodonto-pathogenic bacteria might also affect the foetus directly, as some of these bacteria have been detected in amniotic fluid [2] and the foetus can produce IgM antibodies against periodonto-pathogenic bacteria detected in the oral flora of the mother [3]. Periodontal disease has also been associated with foetal growth restriction and pre-eclampsia [6]. However, in some studies, no improvement in reproductive health was observed in women after periodontal therapy [6].

Diabetes mellitus

Diabetes mellitus type 2 is known to occur due to decreased responsiveness of the target cells to insulin, which is likely a sequel of structural changes of insulin receptors or their decreased number. Elevated circulating levels of IL-6, tumour necrosis factor alpha (TNF-α) and high-sensitivity capsule-reactive protein (hs-CRP), which can worsen insulin resistance and therefore impair glycaemic control, have been shown in several studies [8, 26-27]. Although TNF-α has been proposed to induce insulin receptor changes [27], in a recent study TNF-α is reported to be actually significantly lower in periodontitis patients than in the healthy controls [19]. Conversely, diabetes mellitus is known to affect fibroblast metabolism and collagen synthesis and is considered a risk factor for periodontal disease development [8].

Liver and gastrointestinal tract diseases

Intrahepatic cholestasis, liver steatosis, liver abscesses and some other liver changes/diseases have been reported to be associated with periodontal disease in humans and dogs [2, 4, 14, 28-30]. The reverse is also true – liver diseases can affect periodontal health status [31].

Periodontal health, and in particular infections with Campylobacter sp., have also been reported to influence development of chronic inflammatory bowel diseases by modulating local immune response in the gastrointestinal tract [32]. Immune response of the gastrointestinal tract to the periodonto-pathogenic bacteria as P. gingivalis entering the body through the oral route seems to have an important role in the systemic response to these bacteria, even before any clinical signs of disease are observed, as determined by elevated systemic TNF- and nitric oxide levels in mice ingesting P. gingivalis [33]. This response can be expected, since mucosal surfaces form a major interface between the body and the environment and therefore comprise an extensive and complex immune system in order to maintain appropriate immune responses to entering antigens [34].

Other diseases

Periodontal disease has been associated with brain abscesses, uveitis, endophthalmitis and chronic conjunctivitis [2]. Circulating immune complexes are a possible trigger of mast cell activation leading to chronic urticaria [2] and a likely cause of glomerulonephritis [4, 14]. A link between rheumatoid arthritis and periodontal disease has been suggested in clinical and experimental studies, where the “two-hit” model was suggested. The primary “hit” being of chronic extra-synovial inflammation such as periodontitis, followed by an “arthritogenic hit” to induce rheumatoid arthritis, leading to an exacerbated response [35]. Dental plaque bacteria can also be a source of osteomyelitis and implant infection [2].

Oral hygiene and periodontal treatment

To prevent gingivitis and periodontitis, daily tooth brushing is crucial to prevent de novo plaque formation [36], although dietary factors significantly influence development of gingivitis in the absence of oral hygiene [37], which might be of significance for oral health of dogs and cats. Periodontal treatment with routine scaling and polishing is indicated when accumulation of plaque (and calculus) associated with gingivitis is observed, and these cannot be removed with oral home care [38].
A periodontal treatment plan can only be made once thorough oral examination of the animal under general anaesthesia is performed, including full-mouth radiographs (Fig. 2) and dental charting (Figs. 3a-d). Scaling and selective polishing (Figs. 4a, 4b) are always performed, followed by advanced periodontal treatment as needed [38]. Although complete periodontal treatment is associated with decrease in pro-inflammatory cytokines in serum, improved glycaemic control in diabetic patients and reduced risk of preterm delivery in humans [3, 8, 27], the results of different studies are conflicting, some other showing no impact of the treatment [39] or revealing very heterogeneous systemic inflammatory immune response to periodontal therapy [9].

Periodontal treatment should include analgesia, especially when advanced procedures are employed, and non-steroidal anti-inflammatory and analgesic drugs should be considered if safe to use in a selected case [40]. In addition, use of topical antiseptic (chlorhexidine) gels or oral rinses is recommended to prevent plaque formation, but antibiotic use should be limited to selected cases. Antibiotic use can be bacteraemia-prophylactic and/or therapeutic [40].
Antibiotics should be used to prevent bacteraemia in high-risk patients only (patients with clinically evident cardiovascular, renal or liver diseases; immunocompromized patients, including those treated with immunosuppressive or chemotherapeutics drugs, or having history of splenectomy; and patients with surgical orthopaedic implants). However, a transitory bacteraemia is known to have minimal impact on otherwise healthy patients [41-42]. To prevent transitory bacteraemia, perioperative use of antibiotics should be considered (ideally intravenous application at induction to anaesthesia), choosing a broad-spectrum bactericidal antibiotic [40]. When antibiotics are used for longer-term treatment (therapeutic use of antibiotics), they are indicated in cases where tissues are severely affected and surgery procedures are very involved or in the presence of osteomyelitis.

In dogs, amoxicillin-clavulanic acid seems a good choice [43], although bacterial resistance is an emerging problem from antibiotic misuse [44].

In addition, topical application of antibiotics such as doxycycline gel has been suggested in dogs with periodontitis, to achieve high local concentration of the antibiotic with low risk for systemic side effects [45]. However, recently subgingival delivery of doxycycline has been found to have no long-term benefits for periodontal health in humans [46].

Antimicrobial therapy applied systemically or topically, can improve treatment outcome by reducing bacterial load (it does not improve healing itself), but ideally microbiologic testing is done prior to antibiotic selection and antimicrobial therapy cannot compensate for poor mechanical/instrumentation treatment and should therefore never be used as a sole treatment [40, 47-48].

Conclusion

Although systemic effects of periodontal disease in animals are under investigated, data from human periodontal medicine are suggestive of this oro-systemic link, although in some points conflicting. Most of the data indicate that periodontitis can stimulate and/or perpetuate inflammation in distant tissues/ organs. However some recent data suggest that also in the very early phases of periodontal disease (i.e. gingivitis or oral pathogens only entering the body through the oral route without causing disease) local and systemic elevation of pro-inflammatory cytokines and acute phase proteins occurs, although the significance of this needs to be clarified further.

Until the association between periodontitis and systemic diseases is more clear, it is crucial to prevent periodontal disease, which can be in most cases easily achieved with regular plaque removal by daily tooth brushing. Once the disease has developed, thorough periodontal treatment is suggested, especially in debilitated animals.

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References

The evaluation of dentition and occlusion in dogs

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SUMMARY

Breed standards differ widely between breeds and from country to country within the same breed regarding occlusion and dentition. The decision to accept missing teeth or malocclusion seems to be arbitrary. A professional evaluation of the dentition and occlusion using a standardized template would provide breeders, clubs and judges a useful tool to better apply acceptable standards.

Proposal

There is no an internationally recognised official document used by dental specialists to assess dentition in animals. The proposed document may be of great assistance to breed clubs, national and international judge, breeders and veterinarians.

Show judges are required to assess full dentition and occlusion without knowledge of what is physiological or not. This leads to subjectivity resulting in great discrepancy between judges. On the other hand, some morphological goals (breed standards) are not in keeping with a healthy, functional, comfortable mouth.

Template

The template sets out a detailed evaluation system of the following: tooth number, tooth position and jaw occlusion.

Conclusion

A professional evaluation of the dentition and occlusion using a standardized template would provide breeders, clubs and judges a useful tool in the selection and judging processes for disqualification. Malocclusion and missing teeth are among these disqualifying criteria. However, no official assessment system, endorsed by veterinary specialists, for the evaluation of occlusion and dentition exists in dogs, as has been created for the evaluation of hip and elbow dysplasia, patella luxation and some inherited ocular conditions. As a result, breeders, clubs and judges have selected or disqualified animals without specific and universally accepted evaluation criteria. Although clubs are free to establish their own criteria regarding the ideal external appearance of their breed and the measures to be taken to achieve this, breeders should base their criteria on knowledge of what is considered physiologically normal, what criteria are used to evaluate normal occlusion, how many teeth and which teeth are considered normal, and what the normal position for each tooth is. Veterinarians have the responsibility...

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to make recommendations to clubs in this regard and, in particular, to discourage any attempt to favour a phenotype that could lead to pain or discomfort. Recommendations should be based on accepted standard nomenclature and definitions of dentition and occlusion that can be universally applied to all breeds in all countries. In the following, standard definitions adopted in veterinary dentistry are reviewed and a schema for the evaluation of dentition and occlusion in dogs is presented.

Four aspects are considered in the evaluation of malocclusion and abnormal dentition. These are occlusion itself, the position of each tooth, the number of teeth present, and the size and shape of each individual tooth. The latter is rarely, if ever, mentioned in breed standards to date. Other tools that may ultimately prove useful for further defining occlusion and dentition include radiographic examination. Breed-specific ranges of the craniofacial angle measured on radiographs could be one such application [2].

Normal occlusion in dogs

The skull shape plays an important role in the occurrence of malocclusal and variation in teeth numbers. Although dog breeds can be divided into three basic types based on skull shape (brachycephalic, mesocephalic and dolichocephalic), the American Veterinary Dental College (AVDC) defines dental occlusion as the perfect interdigitation of the upper and lower teeth, and describes the ideal position of teeth in the dental arches in terms of the occlusal, inter-arch and interdental relationships of teeth of the archetypal mesocephalic dog (i.e. wolf) [1]. With the jaw closed, the maxillary arch is slightly larger than the mandibular arch such that the upper teeth overhang the lower teeth like a lid on its box. The AVDC defines normal occlusion using a description of occlusion of the incisors, of the triad (third maxillary incisor, maxillary canine and mandibular canine), of the premolars, and of the carnassials, respectively, as follows: “The maxillary incisor teeth are all positioned rostral to the corresponding mandibular incisor teeth. The crown cusps of the mandibular incisor teeth contact the cingulum of the maxillary incisor teeth. The mandibular canine tooth is inclined labially and bisects the interproximal (interdental) space between the opposing maxillary third incisor tooth and canine tooth. The maxillary premolar teeth do not contact the mandibular premolar teeth. The crown cusps of the mandibular premolar teeth are positioned lingual to the arch of the maxillary premolar teeth. The crown cusps of the mandibular premolar teeth bisect the interproximal (interdental) spaces rostral to the corresponding maxillary premolar teeth. The mesial crown cusp of the maxillary fourth premolar tooth is positioned lateral to the space between the mandibular fourth premolar tooth and the mandibular first molar tooth” [1]. Normal occlusion should always be evaluated based on fulfilment of these criteria. This normal occlusion is also referred to as orthoclusion or Class 0 occlusion [3]. However, mandibular mesiolclusion (Class 3 malocclusion), in which the mandibular teeth occlude rostral in their relationship to the maxillary teeth, is common in many brachycephalic breeds and is considered normal in the standards of these breeds. Some breed standards have therefore defined this configuration as Class 0 instead of merely stating that a Class 3 malocclusion is accepted as normal in the breed [3]. Such breed-specific deviations to the general accepted definition of what constitutes each class of occlusion should be discouraged to avoid misunderstanding.

Definition of malocclusion

Malocclusion is defined by the AVDC as any deviation from normal occlusion as described above, and may be due to abnormal positioning of a tooth or teeth (dental malocclusion) or due to asymmetry or other deviation of bones which support dentition (skeletal malocclusion) [1]. Malocclusion is classified as Class 1 (neutroclusion), denoted as MAL/1 by the AVDC, in which the relationship between the dental arches is normal but one or more individual teeth are malpositioned, Class 2 (mandibular distoclusion), denoted as MAL/2, in which the mandibular arch occludes caudal to its normal position relative to the maxillary arch, and Class 3 (mandibular mesiolclusion), denoted as MAL/3, in which the mandibular arch occludes rostral to its normal position relative to the maxillary arch [1]. Asymmetrical skeletal malocclusions in which there is a difference in length of the two maxillae or mandibles are unclassified in the AVDC system but classified as Class 4 malocclusions by some authors [3].

Dental Malocclusion

Dental malocclusion is a malpositioning of one or more teeth and is, as such, a neutroclusion (Class 1 malocclusion). The following dental malocclusions are described by the Nomenclature Committee of the AVDC [1]:

Distoversion (DV) describes a tooth that is in its anatomically correct position in the dental arch but which is abnormally angled in a distal direction (Fig. 1) [1]. This is very often a sequela of severe Class II malocclusion, when the lower canines occlude distal to the upper canines forcing the upper canines to deviate from their normal angle.

Mesioversion (MV) describes a tooth that is in its anatomically correct position in the dental arch but which is abnormally angled in a mesial direction [1]. Maxillary canine MV, commonly also referred to as “spearing” or “lance canine,” can result from retained deciduous teeth. However, Shetland sheepdogs are very frequently affected and the condition is likely inherited in some breeds (Fig. 2) [4].

![Fig. 1 Distoversion of the left lower canine combined with mesioversion of the upper left canine.](image)
Linguoversion (LV) describes a tooth that is in its anatomically correct position in the dental arch but which is abnormally angled in a lingual (palatal) direction (Figs. 3, 4) [1]. This is also referred to as palatoversion for the maxillary teeth. Mandibular canine LV is very common and frequently combined with Class II malocclusion. In addition, a narrow mandible can also lead to canine linguoclusion as well as LV of incisors due to a lack of sufficient space in the mandibular arch. The common term, “base narrow canines” is confusingly used both to describe mandibular canine LV and narrow mandible leading to canine linguoclusion.

Labioversion (LABV) describes an incisor or canine tooth that is in its anatomically correct position in the dental arch but which is abnormally angled in a labial direction (Fig. 5) [1]. In Shetland sheepdogs, mandibular LABV may occur as a sequela to maxillary canine MV as the lower canine is forced labially by the malpositioned upper canine. In addition, LABV of the mandibular incisors is frequently encountered in older dogs, especially in Collies, as well as in dogs affected by periodontal disease.

Buccoversion (BV) describes a premolar or molar tooth that is in its anatomically correct position in the dental arch but which is abnormally angled in a buccal direction [1]. Brachycephalic breeds are prone to BV due to dental crowding. The term vestibuloversion may also be used synonymously with both labio- and buccoversion.
Crossbite (XB) describes a malocclusion in which a mandibular tooth or teeth have a more buccal or labial position than the antagonist maxillary tooth [1]. This can be classified as either rostral or caudal. In rostral crossbite (RXB, similar to anterior cross bite in human terminology) one or more of the mandibular incisor teeth is labial to the opposing maxillary incisor teeth when the mouth is closed (Fig. 6) [1]. This situation is very often seen associated with Class 3 malocclusion. In a pure Class 1 RXB, the teeth other than the incisors occlude normally. In caudal crossbite (CXB, similar to posterior cross bite in human terminology) one or more of the mandibular cheek teeth is buccal to the opposing maxillary cheek teeth when the mouth is closed (Fig. 7) [1]. This is rare and may be developmental or acquired in trauma or jaw fracture.

Besides abnormally angled teeth, dental malocclusion may also result from crowding, causing an irregularly arrangement of teeth within the dental arch (Figs. 8, 9), or from axial rotation (torsiversion) of teeth (Fig. 10). Both of these occur most often in brachycephalic dogs. Occasionally, teeth may appear rotated when deviation of the mandibular body is present, in which case malocclusion is of skeletal and not dental origin (Fig. 11).

Other dental malocclusions not specifically listed in the AVDC classification are supraocclusion and infraocclusion. Supraocclusion, also called overeruption, supereruption or
suprclusion, refers to a tooth that extends beyond the occlusal plane. This is uncommon and must be differentiated from luxation of teeth associated with periodontal disease or trauma. Infraoclusion, also called infraclusion or infraversion, refers to a tooth that has failed to erupt fully and reach the plane of occlusion (Fig. 12). Such partially impacted teeth are sometimes the result of increased pressure during eruption when the crown meets another tooth or the palate, most frequently observed in mandibular canines and mandibular first incisors.

Finally, if we consider the occlusion of individual teeth with their occluding counterpart, we should introduce the term linguoclusion and labioclusion. This nomenclature is relative to incisors only. An incisor is in linguoclusion when it occlude lingual to the normoclusion, in labioclusion when it occlude labial to the normoclusion.

**Skeletal malocclusion**

Symmetrical skeletal malocclusions are further classified as Class 2 and 3 malocclusions. Class 2 malocclusion (mandibular distoclusion) can be due either to a short mandible (mandibular brachygnathism) or a long maxilla (maxillary prognathism) (Fig. 13), whereas Class 3 malocclusion (mandibular mesioclusion) can be due either to a long mandible (mandibular prognathism) or a short maxilla (maxillary retrusion) (Fig. 14).

Asymmetrical skeletal malocclusion in which there is mesioclusion on one side and distoclusion on the other side has been classified as Class 4 malocclusion, and is commonly referred to as “wry bite” [3]. However, in the ADVC classification, the term “wry bite” is discouraged, and asymmetrical malocclusions are unclassified and divided into three types as follows.

Maxillary-mandibular asymmetry in a rostro-caudal direction: this occurs when mandibular mesioclusion or distoclusion is present on one side of the face while the contralateral side retains normal dental alignment or when mandibular mesioclusion occurs on one side of the face and mandibular distoclusion on the other side [1].

Maxillary-mandibular asymmetry in a side-to-side direction: this occurs when there is loss of the midline alignment of the maxilla and mandible (Fig. 15) [1].

**Fig. 12** Infraoclusion of the lower right canine combined with a persistent deciduous canine and incisor crowding.

**Fig. 13** Class 2 malocclusion (mandibular distoclusion).

**Fig. 14** Class 3 malocclusion (mandibular mesioclusion).

**Fig. 15** Class 4 malocclusion (maxillary-mandibular asymmetry in a side-to-side direction) with loss of midline alignment.
Although 42 teeth is considered full dentition, the presence of 42 teeth alone does not necessarily imply full dentition; an individual dog may have a supernumerary incisor and a missing premolar or a persistent deciduous tooth may be present with no permanent tooth erupted due to full impaction or loss of the permanent tooth. In both cases, 42 teeth are present but cannot be considered full dentition. Evaluation of dentition therefore requires scrupulous examination of the open mouth, which may require sedation in the uncooperative patient. When there is any doubt as to the presence or absence of a tooth, such as with gingival operculum or impaction, radiographic survey of the mouth should be considered.

**Tooth size and shape**

The shape and the size of individual teeth are rarely considered in breed standards, but malformation of tooth crowns or tooth roots are occasionally found in dogs. These may be congenital or developmental. Abnormalities in tooth size include macrodontia and microdontia. Abnormalities in tooth shape include shell teeth, peg teeth (Fig. 18), and taurodontism (vertical enlargement of the tooth body and pulp chamber at
the expense of the roots). Abnormalities in tooth development include tooth fusion (Fig. 19), concrescence, germination, and twinning.

**International breed standards**

The FCI encompasses 84 national canine societies whose breed clubs recognise and apply the rules and standards of the FCI. Beside the FCI, two large national societies, the American Kennel Club (USA) and the Kennel Club (UK), as well as several smaller organisations, use their own schemes and breed standards. As each breed club has its own specific standards, these vary from breed to breed. Indeed, for some breeds, the standards describe a requirement of full dentition (42 teeth) and normal occlusion. However, requirements of other breeds are more detailed and specific. For example, the Boxer breed standard of the Kennel Club includes the requirement “undershot jaw, canines set wide apart with incisors (six) in straight line in lower jaw” [5]. In addition, some organisations list specific exclusion criteria, such as undershot or overshot jaw, but the Kennel Club does not impose exclusion criteria and merely states “any departure from the foregoing points should be considered a fault and the seriousness with which the fault should be regarded should be in exact proportion to its degree and its effect upon the health and welfare of the dog” [5]. This gives breeders and judges great freedom to accept or reject individual animals with characteristics departing from the written standard. Although the FCI does include specific disqualifying criteria, these vary greatly from breed to breed. As breed organisations edit their own standards and rules, comparison of standards between the three largest organisations reveal disparate and sometimes contradictory criteria (Table 1).

In addition, club members of the FCI sometimes subject breeding dogs to more severe selection criteria than those contained within the FCI standards, differing from one country to the next. For example, the FCI standards for Golden Retrievers require “a regular and complete scissor bite”. However, the Swiss Retriever Club allows up to 4 missing teeth [6], the German Retriever Club allows up to 6 missing teeth [7]. Clearly, if dogs are to be shown and judged on both national and international platforms, breed clubs must come to a consensus regarding disqualifying criteria.

**Dental evaluation schema**

In order to facilitate the standardisation of evaluation of dentition and occlusion in breeding dogs, the following assessment tool is proposed. The tool encompasses different templates that use objective, well-defined and unequivocal criteria to evaluate the number of teeth, alignment of individual teeth and occlusion. The evaluation of these criteria should be certified by the examiner who personally evaluates the dog.

The number of teeth present is assessed by identifying each tooth using a standard canine dental chart (Fig. 20). If there is any doubt as to the presence of a tooth (questionable impaction or missing tooth), a radiographic survey is used as definitive

---

**Tab. 1 Comparison of requirements in the breed standard of the Boxer in three breeder organisations.**

<table>
<thead>
<tr>
<th></th>
<th>Kennel Club, UK</th>
<th>American Kennel Club</th>
<th>FCI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Occlusion</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classe III (Undershot)</td>
<td>Mandatory</td>
<td>Mandatory</td>
<td>Mandatory</td>
</tr>
<tr>
<td>Lower jaw protruding beyond the upper and curving slightly upward</td>
<td>Mandatory</td>
<td>Mandatory</td>
<td>Mandatory</td>
</tr>
<tr>
<td>Teeth and tongue not visible with closed mouth</td>
<td>Mandatory</td>
<td>Mandatory</td>
<td>No mention</td>
</tr>
<tr>
<td>Corner upper incisors fitting snugly in back of the lower canine teeth</td>
<td>No mention</td>
<td>Mandatory</td>
<td>No mention</td>
</tr>
<tr>
<td>Torsion or deviation of the lower jaw</td>
<td>No mention</td>
<td>No mention</td>
<td>Default</td>
</tr>
<tr>
<td><strong>Teeth number</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presence of 6 lower incisors</td>
<td>Mandatory</td>
<td>No mention</td>
<td>No mention</td>
</tr>
</tbody>
</table>

**Fig. 20 Standard canine dental chart for the evaluation of the number of teeth present in dogs.**
proof. In addition, every supernumerary and retained deciduous tooth must be declared.

The alignment of teeth is assessed by examining each individual tooth. Teeth that are in their correct position but are misaligned, rotated or supra-/infraocluded are listed by their number given on a standard canine dental chart using a schema that depicts abnormal tooth occlusion (Fig. 21). Judging the angle of teeth is not always easy as there is no absolute and discrete boundary between a normal and abnormal angle. When assessing upper teeth, the vertical axis of the crown of the incisors and canines should be at a right angle to the plane of the palate. For teeth in vestibuloversion, labioversion applies only to incisors and canine teeth; buccoversion applies only to premolars and molars. Vestibuloversion and lingualversion are most frequently encountered in canine teeth. When evaluating lower canines, the tooth is in labioversion when the tip of the crown fails to touch the diastema between the upper canine and upper third incisor with a closed jaw, and it is in lingualversion when the tip of the crown impacts the palate with a closed jaw. Rotation and crowding is most often encountered in premolars and incisors. When assessing premolars, the mesiodistal plane of the upper and lower crowns must align with the axis of the lateral wall of the maxilla and mandibular body, respectively. Infraocclusion is most frequently encountered in the lower canine, first incisor and first premolar. The lower canine is evaluated by comparing contralateral lower canine. The first incisor is evaluated in relation to adjacent incisors. In the first premolar, infraocclusion is seen as partial covering of the tooth by gingival tissue or even bone.

Tooth position and skeletal occlusion is assessed by evaluating the relative position of the incisors, triad, premolars and carnassials teeth separately, according to the description of normocclusion [1] using 4 separate templates. For the incisors (Fig. 22), if a mandibular incisor is angled normally but is positioned more labial/rostral to its maxillary counterpart, this is evaluated as

---

**Type of version**

<table>
<thead>
<tr>
<th>Mesioversion</th>
<th>Distoversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linguo-, Palatoversion</td>
<td>Buccoversion/Labioversion</td>
</tr>
<tr>
<td>Rotation (Torsiversion)</td>
<td>Crowding</td>
</tr>
<tr>
<td>Infraocclusion</td>
<td>Supraocclusion</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 21 Chart for the assessment of individual tooth alignment.

Fig. 22 Chart for the assessment of occlusion of the incisors.
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<table>
<thead>
<tr>
<th>Occlusion of the lower canines to the upper jaw</th>
<th>Occlusion of the premolars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normocclusion</td>
<td>Normocclusion</td>
</tr>
<tr>
<td>Mesioclusion grade I</td>
<td>Mesioclusion grade I</td>
</tr>
<tr>
<td>Mesioclusion grade II</td>
<td>Mesioclusion grade II</td>
</tr>
<tr>
<td>Mesioclusion grade III</td>
<td>Distoclusion grade I</td>
</tr>
<tr>
<td>Mesioclusion grade IV (Canine visible with closed mouth)</td>
<td>Distoclusion grade II</td>
</tr>
<tr>
<td>Distoclusion grade I</td>
<td></td>
</tr>
<tr>
<td>Distoclusion grade II</td>
<td></td>
</tr>
<tr>
<td>Distoclusion grade III</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 23 Chart for the assessment of occlusion of the triad.

Fig. 24 Chart for the assessment of occlusion of the premolars.

grade I (tip of incisors occlude directly onto each other), grade II (mandibular incisor is labial to maxillary incisor with contact between the two teeth), grade III (mandibular incisor is labial to maxillary incisor with no contact between the two teeth), or grade IV (as grade III and mandibular tooth is visible with closed mouth) labioclusion. If only some mandibular incisors are rostral to the maxillary incisors but others are in normal position, this corresponds to a rostral crossbite. If all mandibular incisors are rostral to the maxillary incisors, a Class 3 malocclusion must be considered. A Class 3, Grade I malocclusion is sometimes referred to as a “level bite.” A linguoclusion is present if mandibular incisors are more caudal than normal with respect to the maxillary incisors such that there is no contact between the mandibular and maxillary incisors. If all mandibular incisors are in linguoclusion, a Class 2 malocclusion is present.

For the triad, occlusion is evaluated by examining the position of the lower canine with respect to the upper corner incisor and upper canine (Fig. 23). In normocclusion, the lower canine is
equidistant to both upper teeth. If the lower canine is positioned more mesial or distal than normal, this is evaluated as grade I (narrower or larger space between the lower canine and upper incisor than between the lower canine and upper canine without overlap of lower and upper teeth), grade II (overlap between the lower canine and upper incisor or upper canine), grade III (tip of lower canine is more mesial than upper incisor or more distal than upper canine), or grade IV (tip of lower canine is more mesial than upper incisor and lower canine is visible with mouth closed) mesiocclusion or distocclusion, respectively.

Evaluation of occlusion of the premolars is performed only after the number of premolars has been accurately assessed, using a similar template as that for other teeth (Fig. 24). Malocclusion of the premolars is evaluated as grade I (the tip of the upper first premolar is in line with the tip of the lower first or second premolar) or grade II (the tip of the upper first premolar is more distal than the tip of the lower second premolar or more mesial than the tip of the lower first premolar) mesiocclusion or distocclusion.

Finally, the relationship of the carnassials (upper fourth premolar and lower first molar) is evaluated (Fig. 25). If the upper fourth premolars are palatal (lingual) to the lower fourth premolars and first molars, a caudal crossbite is present (Fig. 25).

Discussion

Breed standards are mainly based on physical, external characteristics and occasionally on health issues. If standards are subjected to precise criteria, these must be defined in a manner such that they are unequivocally understood and detrimental characteristics can be recognised and discouraged. Some malocclusions, such as Class 3 malocclusion, are well tolerated without pain or discomfort but others, such as Class II malocclusion, can be very painful, lead to periodontal disease, palatal impingement or tooth displacement. If an undershot jaw is generally without consequences, a level bite on the other hand, may lead to severe abrasions with periodontal and endodontic consequences. Paradoxically, some breed standards tolerate level bite but disqualify an undershot jaw. There is therefore clearly a need for precise definitions within breed standards as well as education and guidance of clubs responsible for writing standards.

The use of inadequate and unprofessional nomenclature in international breed standards can lead to imprecise or confusing definitions. The use of the terms overshot or undershot often only reflects malocclusion of the rostral aspect of the jaw because this is what is examined. However, when the rostral teeth are in normal occlusion, the position and direction of the premolars may be incorrect. Assessment of occlusion must therefore be performed by evaluating the incisors, triad, premolars and carnassials teeth simultaneously. Use of the terms Class II and III malocclusion then becomes a more objective reflection of the true relationship between the upper and lower jaws.

The definition of normal full dentition is also controversial although the majority of breed standards require full dentition. This is generally accepted to be 42 teeth in mesocephalic dogs and wild canidae from which they evolved. Indeed, from the small fennec fox to the taller wolf, the skull shape is proportionally the same, only tooth size is adapted to allow a regular position and alignment of the dentition. Although the dolichocephalic skull may easily support one or several supernumerary teeth without consequence, and the brachycephalic skull only supports 42 teeth with crowding, rotation or misalignment, the shape of the skull has been altered by breeding at a rate far exceeding that of the ability of evolution to adapt. Indeed, it took 60 million years of evolution and adaptation to skull shape and diet from the early carnivores, miacis, with 44 teeth to the modern canidae and felidae. Although modern dogs have 42 teeth, the skull shape of the brachycephalic dog is more similar to that of felidae with 28-30 teeth. It can therefore be argued that requiring 42 teeth in a brachycephalic dog is counter-evolutionary and the practice of disqualifying brachycephalics with less than 42 teeth should be discouraged.

Tooth size is also a criterion that may desire greater consideration as a factor relative to head and jaw size affecting crowding and tooth rotation. Indeed, small dogs were found to have larger mandibular first molar teeth relative to the height of the mandible than large dogs [8]. Such proportionally oversized teeth in small breeds may favour periodontal disease, tooth loss and jaw fracture. However, there is currently no practical and easy way to evaluate tooth size in relation to jaw size without radiographic examination.

One of the main concerns of veterinarians, breeders and clubs is the potential of specific undesirable traits to be inherited. Skeletal malocclusion is generally accepted to be inherited. The growth of the upper and lower jaws is independently fixed genetically [9]. In one study, mandibular shape was shown to have a complex inheritance involving several genes [10] although another study revealed a simple autosomal recessive mutation causing overshot jaw in the German shorthair pointer.
endodontic disease due to abrasion of malaligned teeth. or indirectly, such as periodontal disease due to crowding or by impingement of the lower canine in the palatal mucosa, it is likely to cause pain or discomfort either directly, such as inherited malocclusion should be considered unacceptable if they are likely a sequela to skeletal malocclusion or if they have been demonstrated to be inherited, such as mesioversion of the upper canines in Shetland sheepdogs. Inherited malocclusions are not necessary unacceptable, otherwise breeds with Class 3 malocclusion, such as the Boxer, could not exist. However, inherited malocclusion should be considered unacceptable if it is likely to cause pain or discomfort either directly, such as by impingement of the lower canine in the palatal mucosa, or indirectly, such as periodontal disease due to crowding or endodontic disease due to abrasion of malaligned teeth.

Dental malocclusions are less suspected to be inherited. However, teeth malalignment is often a sequela to skeletal malocclusion, and therefore indirectly the result of inherited traits. As tooth crowding will occur when there is insufficient space for the widest mesio-distal diameter of a tooth to be accommodated between the teeth on either side of it, shortening of the lower jaw will lead to dental crowding [13]. In addition, allometrical expansion of the upper arch allows an outward movement and rotation of the teeth during development and shortening of the upper jaw can therefore lead to tooth rotation [13]. Moreover, acquired dental and skeletal malocclusion may be caused by retained deciduous teeth or trauma to the bone or soft tissues during jaw growth [14]. Missing teeth may also be of genetic origin, as is the case of hypodontia in Kerrie Blue Terriers, in which absence of the second premolars is autosomal recessive but agenesis of the fourth premolars have a more complex genetic mechanism [15].

The assessment charts proposed herein allow dentition and occlusion to be evaluated in a standardised and objective manner, with a view that each dog can be assessed in a reproducible way regardless of examiner. It is then the responsibility of breed clubs to decide which criteria are acceptable in each breed. Veterinarians advising breed clubs should base their recommendations on whether specific traits are potentially painful and inherited. Until proven otherwise, all skeletal malocclusions (Class 2, 3 and 4) should be regarded as inherited. Dental malocclusions should be regarded as inherited if they are likely a sequela to skeletal malocclusion or if they have been demonstrated to be inherited, such as mesioversion in low-grade otocephaly. Inherited malocclusions are not necessary unacceptable, otherwise breeds with Class 3 malocclusion, such as the Boxer, could not exist. However, inherited malocclusion should be considered unacceptable if it is likely to cause pain or discomfort either directly, such as by impingement of the lower canine in the palatal mucosa, or indirectly, such as periodontal disease due to crowding or endodontic disease due to abrasion of malaligned teeth.

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[9] Stockard RC. The genetic and endocrine basis for differences in form and behaviour. Wistar Institut. 1941


Oral Proliferative Lesions in the Dog and Cat

L. Verhaert(1)

SUMMARY

Proliferative lesions are regularly seen in the oral cavity of dogs and cats. Examination includes a full physical examination, imaging, and histopathology of a representative biopsy. Proliferations include reactive and neoplastic lesions. Some may present as an epulis or gingival growth. The most common reactive lesion is gingival hyperplasia. Neoplastic lesions include odontogenic and non-odontogenic tumours. The most common odontogenic tumours are peripheral odontogenic fibroma and acantomatous ameloblastoma. The most common non-odontogenic neoplasms are malignant melanoma and squamous cell carcinoma. Prevalence, clinical presentation and treatment options will be discussed, with special emphasis on newer treatment modalities. For most proliferative lesions however, surgery is still the most important part of the treatment plan. Oral proliferations, epulis, reactive lesions, odontogenic tumours, non-odontogenic tumours.

This paper has been commissioned by FECAVA.

Introduction

Oral tumours represent approximately 5-10% of all tumours in dogs and cats [1,2,3,4]. In dogs a large proportion of proliferations are reactive or benign [5], while in cats the majority of proliferations are malignant [3]. A variety of conditions, including infectious conditions, can present as a proliferative lesion or a local swelling in the mouth. Also, a non-healing ulcer which looks like an infectious condition may well be a malignancy [6,7]. The exact nature of any lesion can only be determined by histopathological examination. The taking of a biopsy is indicated for all proliferative or other suspicious lesions such as non-healing ulcers. The mainstay in treatment of oral malignancies is radical surgery whenever possible [8].

Clinical signs

Unfortunately most owners do not check the mouth of their pets regularly. Therefore, most patients will present with an advanced stage of disease. Common clinical signs include halitosis, tooth mobility, exfoliation of teeth, bleeding from the mouth, excessive salivation, and nasal discharge when the maxilla is affected. Most patients will not show obvious signs of pain, except when the tongue is affected or the tumour is so advanced that it interferes with mastication or leads to a pathological fracture. Sometimes obvious deformation of the face is the primary reason for presenting the animal.

Clinical approach

1. Physical Examination

Clinical signs observed by the owner, duration and progression of the lesion, former treatments and their results should all be noted. A general physical examination must be performed to look for signs of distant metastasis.

Inspection and palpation of the head may show asymmetry, increased retrobulbar pressure (in distal maxillary lesions), bleeding from the mouth or nose and halitosis. The mass must be carefully inspected and palpated: site, size and consistency of the mass, colour (abnormal pigmentation or loss of pigmentation), presence of ulceration and/or necrosis, fixation to the underlying tissues, tooth displacement, any abnormal mobility of teeth, change in bone contour should all be noted. An example is shown in Fig. 1. The regional lymph nodes should

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be palpated to evaluate size, shape and consistency and whether they are fixed to the surrounding tissues or not.

2. Imaging
Radiographic examination of the affected jaw is mandatory. In most cases the best detail can be obtained with non-screen dental film and an intra-oral radiographic technique. Bone infiltration may be diagnosed by varying degrees of resorption and/or new bone formation. Resorption of bone will only be visible with standard technique when about half of the mineral content has been lost [9]. In some malignancies there may also be evidence of resorption of tooth roots. Common radiographic signs are summarized in table 1. Examples are shown in Fig. 2.

In the maxilla, overlap with nasal structures obscures the margins of the tumour. Advanced imaging techniques such as CT-scan or MRI are therefore indicated before attempting extensive surgery (Fig. 3). CT-scan can detect differences in tissue density that are too small to view with conventional radiographs and can therefore also be useful for evaluating mandibular lesions. In people, conventional CT scan proved to be a technique with a high sensitivity and specificity for evaluating invasion of squamous cell carcinoma in the mandibular canal, provided thin slices (maximum 3mm) were used [10,11]. In one veterinary study MRI was found to be more accurate to diagnose the size of lesions and invasion of adjacent structures especially in the more distal part of the maxilla, CT scan was superior for viewing calcification and erosion of cortical bone [12]. For soft tissue lesions (tongue, soft palate, ...) MRI is the most suitable technique to evaluate the extent of the tumour.

Thoracic radiographs (right lateral, left lateral and dorsoventral or ventrodorsal views) are indicated in all cases of suspected malignancy. Even when these seem to be clear, and there are no signs yet of metastasis, it needs to be kept in mind that a mass in the thorax will only be visible when it exceeds a diameter of 0.5 cm unless large numbers are present [9].

3. Histopathological examination
Large lesions may be benign, and small lesions or non-healing ulcers may be highly malignant. The precise nature and degree of malignancy of the lesion can only be determined by histopathological examination. A representative biopsy (incisional for large lesions or infiltrative lesions, excisional for smaller lesions not showing bone infiltration) should be taken. A fine needle aspirate is usually of limited value in diagnosing oral masses. A biopsy taken atraumatically that falls within the boundaries of the lesion to be excised is unlikely to enhance the occurrence of metastasis [13]. A disposable biopsy punch is commonly used for lesions that are not highly mineralized. Care should be taken to avoid severely inflamed or necrotic parts of the lesion, since these will obscure the histopathological diagnosis, and to avoid surface biopsies that may show only reactive cells.

Regional lymph nodes should be biopsied (fine needle aspirate cytology or surgical biopsy). Surgical biopsy is the best method
for confirming or excluding infiltration, but is a more extensive procedure [14].

Clinical findings and results of the histopathological examination should match: a lesion that looks very aggressive probably is, even if the histopathological result tells otherwise. When there is a mismatch, the findings should be discussed with the pathologist and sometimes additional biopsies will be indicated [15].

4. Clinical staging
Clinical staging is based on the TNM-classification of the WHO. It helps the clinician to evaluate the tumour in a systematic and methodical way, and the stage of the tumour is a prognostic indicator: it describes the clinical extent of disease [16]. T stands for Primary Tumour (size), N for regional lymph node, and M for metastasis. Staging for oral tumours is summarized in table 2.

Patients in stage I and II carry a good prognosis, depending on histological tumour type, and radical surgery is often curative. For stage III patients prognosis is highly dependent on the histological tumour type (stage = extent, histology = degree of malignancy). Stage IV patients carry a bad prognosis.

Epulis
An epulis is a non specific gingival growth. It is a clinically descriptive term used for tumours and tumour-like masses of the gingiva [17,18] (Fig. 4). While half of the epulides are reactive lesions, approximately one out of five epulides is a locally aggressive or neoplastic lesion [18,19]. Therefore, an epulis should always be histopathologically examined.

Reactive Proliferations
1. Gingival Hyperplasia / Fibrous Hyperplasia / Inflammatory Hyperplasia
Gingival hyperplasia may be focal, multiple focal or generalised. It is more commonly seen in dogs than in cats. Some breeds have a predisposition, e.g. boxers [20]. Generalised hyperplasia may be induced by plaque accumulation, but also certain drugs (diphenylhydantoine, cyclosporine, amlodipine) induce hyperplasia [20,21,22] (Fig. 5).

The lesions consist of firm tissue, with or without superficial pigmentation, ulceration, and mineralization (Fig. 6). Clinically gingival hyperplasia can not be differentiated from peripheral odontogenic fibroma, a benign neoplastic lesion.

<table>
<thead>
<tr>
<th>Stage</th>
<th>T</th>
<th>N</th>
<th>M</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>T1</td>
<td>N0, N1a or N2a</td>
<td>M0</td>
<td>Primary tumour less than 2 cm, normal lymph nodes and no signs of metastasis</td>
</tr>
<tr>
<td>II</td>
<td>T2</td>
<td>N0, N1a or N2a</td>
<td>M0</td>
<td>Primary tumour between 2 and 4 cm, normal lymph nodes and no signs of metastasis</td>
</tr>
<tr>
<td>III</td>
<td>T3</td>
<td>N0, N1a or N2a</td>
<td>M0</td>
<td>Primary tumour more than 4 cm, normal lymph nodes and no signs of metastasis Or: primary tumour of any size, ipsilateral lymph nodes affected but not fixed, no signs of metastasis</td>
</tr>
<tr>
<td></td>
<td>Any T</td>
<td>N1b</td>
<td>M0</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>Any T</td>
<td>N2b or N3</td>
<td>M0</td>
<td>Primary tumour of any size, contralateral lymph nodes affected or fixed nodes, no metastasis Or: signs of metastasis</td>
</tr>
<tr>
<td></td>
<td>Any T</td>
<td>Any N</td>
<td>M1</td>
<td></td>
</tr>
</tbody>
</table>
Treatment consists of marginal excision and removing the underlying cause (meticulous plaque control, change medication if induced by drugs).

2. Multiple Epulides in Cats (MFE)
This is an uncommon disease of young adult cats, with no sex or breed predilection. Affected cats present with multiple gingival masses covering the crowns of most teeth (Fig. 7). A lot of confusion exists about the true nature and biological behaviour of the disease. A recent report shows that MFE is reactive in nature (gingival hyperplasia or peripheral ossifying fibroma), most likely from plaque accumulation in certain cats [23]. Treatment consists of marginal excision (gingivoplasty) followed by meticulous plaque control. If recurrence is seen, extraction of teeth at the affected sites results in cure in the majority of cases.

3. Other reactive lesions
Other reactive lesions that may present as an epulis include peripheral giant cell granuloma, pyogenic granuloma and
Neoplastic Lesions: Odontogenic tumours

Odontogenic tumours are usually classified according to the origin of the cells: epithelial, mesenchymal or mixed [24]. A different classification that is sometimes used is based on the presence of induction, which means there is an interaction between ectodermal and mesenchymal cells comparable to what is seen during normal tooth development [25]. In inductive odontogenic tumours, the cells will form dental hard tissue which can easily be identified on radiographs.

Many of the odontogenic tumours present as an epulis, and they may look clinically similar to gingival hyperplasia.

1. Peripheral odontogenic fibroma

Peripheral odontogenic fibroma, also named fibromatous epulis of periodontal ligament origin, is one of the most common odontogenic tumours in dogs [18,19,26]. Other terms that have been used are fibromatous epulis and ossifying epulis, but these terms have to be used with caution, and this growth should not be confused with fibrous hyperplasia with or without ossification.

Peripheral odontogenic fibroma is a benign growth arising from the periodontal ligament, thus it is a tumour of mesenchymal origin. It presents as an epulis, sessile or with a pedunculated base, with a surface that can be intact or ulcerated. It may be superficially pigmented (Fig. 8). The main component of this tumour is a cellular fibroblastic tissue. Different forms of hard tissue formation may occur. In addition, strands of odontogenic epithelium are often present in varying amounts [26].

Treatment consists of marginal excision, though recurrences are frequently reported if excision is not adequate.

2. Ameloblastoma / Acantomatous ameloblastoma (“acantomatous epulis”)

The ameloblastoma is an epithelial neoplasia of enamel organ type tissue which does not differentiate to the point of enamel
formation. It is one of the most common odontogenic tumours in dogs [18,19,26].

Ameloblastomas occur either at the gingival margin (peripheral ameloblastoma, presenting as an epulis) or originate from within the bone (central ameloblastoma). When the lesion is advanced it may be clinically difficult to distinguish between the two types. Some of the central ameloblastomas present as cystic lesions in the bone, advocating the need for biopsy of any cystic lesion in the oral cavity [24]. Because of the similarity with a certain type of ameloblastoma in man, it has been suggested to name this tumour ‘acantomatous ameloblastoma’, without distinguishing between the peripheral and central type [27] (Fig. 9). While this tumour is biologically benign and will not spread, it is locally extremely infiltrative and aggressive, leading to extensive bone resorption, tooth displacement and even tooth root resorption (Fig. 10). Wide surgical excision is the treatment of choice.

Ameloblastoma is sensitive to irradiation. While later development of squamous cell carcinoma at previous sites of orthovoltage irradiation has been reported [28], megavoltage irradiation does not seem to carry as much risk [29].

3. Odontoma
The odontoma is a benign odontogenic neoplasm of mixed origin in which both the epithelial and the mesenchymal cells show complete differentiation, so that enamel and dentin are formed [24,25]. This enamel and dentine are usually laid down in an abnormal pattern. The odontoma is usually discovered in young animals and may be seen in any location of the dental arch. The complex odontoma presents as an unorganized amorphous mass of dental hard tissues with no resemblance to a normal tooth. The compound odontoma consists of multiple small tooth-like structures called ‘denticles’ (Fig. 11). Both types are encapsulated, and often are associated with an unerupted tooth. They are benign lesions, but may cause disruption of teeth, and sometimes are very expansile.

The radiographic appearance is characteristic. The complex odontoma presents as an irregular mass of calcified material surrounded by a radiolucent band. The compound odontoma presents as a variable amount of tooth-like structures.

Treatment is by enucleation of the mass, making sure to remove the entire capsule of the lesion. Prognosis is good and recurrence is not to be expected.

4. Other odontogenic tumours
Other odontogenic tumours are occasionally seen.

**Amyloid producing odontogenic tumour** presents as a gingival mass in dogs and cats. This tumour does not seem to infiltrate bone, but causes erosion of the bone as it grows [26]. Metastasis has never been reported. Treatment is by complete resection.

**Feline inductive odontogenic tumour** is a rare lesion seen in young cats that arises from within the bone. It occurs most often in the rostral maxilla. This tumour is highly destructive, not well circumscribed and requires wide resection [26]. Metastasis has not been reported.

Neoplastic Lesions: non-odontogenic tumours

1. **Malignant Melanoma (MM)**
Malignant melanoma is considered the most common oral malignancy in the dog and accounts for 30-40% of all oral malignancies in this species, though more recent surveys report squamous cell carcinoma as slightly more common [1,2,3,5,30,31]. While most reports suggest a strong predilection for the male (M:F ratio between 2.5:1 and 4:1), a large review of MM reports no sex predilection [31]. MM typically occurs in older dogs that have some oral pigmentation. Malignant melanoma is uncommon in the cat, but exhibits the same biological behaviour in this species as in the dog.

The most common locations are the gingiva and labial/buccal mucosa, but it can also be located on other places (palate, dorsal surface of the tongue) [31]. In gingival lesions dental disruption is common and bone invasion is usually seen (Fig. 12). MM is a tumour with rapid growth, and usually shows ulceration.
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Canine SCC

The most common site for canine SCC is the gingiva (Fig 14). Mean age of affected dogs is 7-9 years, and there is no sex or breed predilection. Papillary SCC, a specific type of SCC, is an uncommon tumour of very young dogs (often less than 6 months of age) [38,39] (Fig 15).

The primary mass is often ulcerated. SCC can present as a chronic non-healing ulcer, without proliferation (Fig 16). Dental disruption is common, bone invasion is found in the majority of lesions, and even tooth roots may be resorbed. The incidence of metastasis of gingival SCC to the regional lymph nodes and lungs is generally low but increases with more caudal sites [5, 6, 8]. Lingual SCC shows metastasis more often [40].

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Treatment of choice is wide surgical excision (at least 1 cm surgical margin). For more rostrally located SCC this is often curative (up to 85 % one year survival rate) [5,8]. SCC is a radiosensitive tumour, but surgical excision gives the best long term prognosis. Often surgery is followed by radiation therapy, especially in larger tumours with a more caudal location, when clean margins are not always easy to achieve. Other treatment options include medical treatment (piroxicam combined with carboplatin) [41] and photodynamic therapy (for lesions not deeper than one centimetre) [42].

Due to the overexpression of COX-2 in canine SCC tumour cells, and/or necrosis. Malignant melanoma may be pigmented or unpigmented (amelanotic). Often amelanotic melanoma is a diagnostic challenge, and is extremely aggressive (Fig. 13).

Prognosis is extremely poor. Surgical excision of very small and early lesions may occasionally be successful, but for larger lesions surgery is no more than palliative, leading to a better quality of life for the patient [5]. Metastasis to the regional lymph nodes and lungs takes place at an early stage in the majority of the patients. Median survival time with aggressive surgery with or without irradiation is 5-9 months, and less than 25% of the patients survive longer than a year [5,31,32]. There is no optimal protocol available for control or prevention of distant metastasis.

Recently a vaccine became available in the USA, which doubled survival times in a clinical trial [33,34]. Other possible future treatments may target Vascular Endothelial Growth Factor (angiogenic therapy) [35]. Recently it has been reported that oral MM cells in dogs show over-expression of COX-2, suggesting that COX-2 inhibitors may be useful in the treatment of canine oral MM [36].

2. Squamous Cell Carcinoma (SCC)

SCC is diagnosed in 20-30% of oral tumours in the dog, though some recent reports show this is currently the most common oral tumour in the dog [1,2,3,30]. In cats it is by far the most common oral malignancy [4,37].

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treatment with COX-2 inhibiting agents (piroxicam, meloxicam) may be a useful adjunct to other treatments. Piroxicam has shown to slow down progression in half of the canine patients with oral SCC [43]. Therefore, it may be useful as the sole agent for owners declining other treatment modalities.

SCC of the tongue and tonsils is less common but also much more aggressive than the gingival form. Tonsillar SCC carries a grave prognosis. Metastasis to the regional lymph nodes develops early in the disease, and at the time of diagnosis 90% of patients will show metastatic disease [44]. Often the primary mass goes unnoticed, and patients are presented for a large mass in the neck region, which is in actual fact the metastatic regional lymph node (Fig. 17).

**Feline SCC**

SCC is the most common oral malignancy in cats (60-70% of all oral malignancies) [4,44]. Oral SCC occurs most commonly in older cats, and there is no known breed or sex predilection [37]. The tumour is most often located in the premolar/molar region of the maxilla, premolar region of the mandible and the tongue (Fig. 18). SCC infiltrates readily into the bone, and often the extent of bone invasion is much greater than expected from the clinical appearance of the lesion [37]. In the tongue, the lesion may present as a non-healing ulcerative lesion in the frenulum, very comparable to what is seen with foreign bodies trapped under the tongue (Fig 19). Often the tumour is not clearly visible, but it can be palpated as a firm mass in the ventral body caudal to the frenulum [5] (Fig 20).

The high incidence in cats has lead to research about possible causes for SCC in this species. Contact with carcinogens, such as flea-collars, topical tick- and flea treatments may contribute to SCC in cats because of their grooming behaviour [45]. Chronic inflammation might be a factor, and higher incidences of SCC have been suggested for cats suffering from chronic stomatitis.

The best treatment option for SCC in the cat is complete surgical excision of early lesions, though even with extensive...
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Feline SCC is not very radiosensitive. Radiotherapy has been used as palliative treatment when combined with a radiosensitizer, not improving survival but improving quality of life [51].

3. Fibrosarcoma

Fibrosarcoma is less common in dogs, but in cats it is the second most common oral tumour [2,4,44]. Fibrosarcoma is most often seen in large breed dogs, with a younger mean age than MM and SCC (approximately 7 years) and in smaller animals presents at an older age (>8y) [5]. Fibrosarcoma is seen most often in the maxilla. It may occur as a protruberant mass at the dental margins and palate (Fig. 21). Fibrosarcomas may also arise from the nasal cartilages, the lateral surface of the maxilla or the palate, as a smooth mass with an intact epithelial covering. Fibrosarcoma is radiologically characterized by extensive bone resorption (Fig. 22). CT scan examination is highly advisable because on radiographs the extent of the lesion will be greatly underestimated. The regional lymph nodes are rarely involved but lung metastasis occurs in approximately 20% of the cases [8].

A specific type, ‘histologically low grade and biologically high-grade fibrosarcoma’, occurs in relatively young dogs, with a predisposition for Golden Retrievers [52]. While biopsies suggest a low histological grade (fibroma or well-differentiated fibrosarcoma), this tumour grows invasively and closely resembles the human aggressive fibromatosis. Fibromatosis is seen as a lesion in the head and neck region in young adult people, with a high recurrence rate after surgery.

Surgery of fibrosarcoma may not always lead to a cure, and recurrences are seen in more than half of the cases after wide or radical resection. The one year survival rates are at 40-45% with surgery alone [8]. The combination of surgery and radiotherapy gives far better survival rates.

4. Osteosarcoma

Osteosarcoma of the oral cavity occurs mainly in medium- to large breed dogs, and usually the patient is middle-aged or older.
therapy with biphosphanates shows promising results, and may lead to palliation (less bone resorption, and less bone pain) and may have a direct anti-tumour action [56,57,58].

5. Other tumours
Many other neoplasms occur in and around the oral cavity. Some examples include: 

**Oral papillomatosis** is occasionally seen, most commonly in young dogs (Fig. 25). Lesions are usually self-limiting and regress within 4-8 weeks without treatment.

**Mast cell tumour** may occur on the lips, or at the labial or oral
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Extramedullary plasmocytoma may occur in the oral cavity. There is no obvious correlation with Multiple Myeloma and complete surgical excision may be curative.

Epitheliotropic T-cell Lymphoma may present with oral cavity lesions (Fig. 26). Usually the first sign is depigmentation of the oral mucous membranes, with or without ulceration. Sometimes true proliferations are seen. Most of the time, the skin is also affected. Prognosis is grave.

When treating less common tumours, literature reports on biological behaviour in humans or biological behaviour of this tumour type at other sites in the body should be used.

Fig. 25 Oral Papillomatosis in a 6 month old American Cocker Spaniel.

Fig. 26a Case presenting with oral depigmentation and ulceration. Fig. 26b Case presenting with obvious proliferative lesions.

Fig. 27 Appearance after mandibulectomy.
Fig. 27a Close up view of jaw – left mandible is removed from first incisor to distal of second premolar.
Fig. 27b Cosmetic appearance.
Infiltrative tumours located on the jaw will require wide excision or radical surgery, which will mean that part of the maxilla or mandible will have to be removed with the tumour. The functional and cosmetic result of these procedures is usually very good (Figs. 27 and 28). Cats seem to tolerate major surgery less than dogs. Surgery of oral tumours is best performed by an experienced (oral) surgeon, and the description of surgical methods falls beyond the scope of this paper.

References


Myths and ethics in small animal dentistry

J. Gawor(1)

SUMMARY

Veterinary Dentistry for the part of public may sound more like a fad than a critical health issue for certain clinical problems. Many people ask if dentistry in small animals means: braces, crowns or golden fillings in dogs’ or cats’ mouths. It is perhaps due to existing prejudices and lack of reflection about dentition similarities among creatures on the Earth. This text about myths, truth and ethics in small animal dentistry is dedicated to those who either have doubts about the importance of oral health or who must struggle with pressure from the pet owners, clients or the public. Myths are collected from the author’s own experience as well as by colleagues from the veterinary dental community. There may also be some other strange ideas, questions or existing information that we should deal with.

Ethics is always a very important part of our profession. Dentistry touches many aspects of hereditary defects in show dogs and therefore it is necessary to respect the selecting criteria to provide the best possible reproductive material and not to interfere with them by camouflaging the defects. On the other hand, it is a crucial task for the veterinarian to provide a functional and comfortable mouth for our patient and not accept the presence of pain and/or infection when there are ready solutions. That is why all problems causing discomfort or pathology needs treating. Ethics also require continuous development and post graduate education of the veterinary dentist, which provide not only a higher quality of services but also less iatrogenic complications, improved image of profession and satisfaction of the clients.

A known example of myth in veterinary dentistry is the former treatment of rabies by cauterization of the sublingual tissue called lyssa. More recent myths are related to the pigmented palate, which in many peoples’ opinion characterizes only aggressive dogs. None of these myths is currently supported by any scientific studies. Black or darkly pigmented dogs, however, may suffer more often from malignant melanoma than others [1]. During the preparation of this text the author asked colleagues from many countries about their local myths and prejudices related to oral cavity conditions. Some of these myths are really surprising, particularly because of the fact that veterinarians may still believe in it. Albert Camus said: “The evil that is in the world almost always comes of ignorance” and it may be the best comment for those prejudices.

A common question asked by pet-owners before surgical procedures in the oral cavity is: How can my dog or cat survive without teeth? The veterinary dentist community fully agrees with the opinion of Dr Hale expressed in his text about periodontal treatment: “The dog is far better off having no teeth than having bad teeth (...) preserving bad teeth in the face of a poor or questionable prognosis serves no positive purpose” [2]. This statement of Dr Hale comes from the fact that dogs as well as cats have less and less opportunity to express their territorial instinct and defend their areas. Hunting and killing prey animals are getting even less common [2].

This text consists of three parts. In the first part myths are listed and author’s comment to them with appropriate literature if required. The second part contains ethical considerations also in listing format. In the last part the reader can find some opinions which are more like foundations of veterinary dentistry than advanced advices.

Myths

Bad breath is something normal for carnivores. No it is not normal. Bad breath (halitosis) is caused by the presence of VSC (Volatitle Sulphur Compounds) produced by microorganisms (mostly bacteria) [3]. The majority of patients with bad breath have dental problems. Periodontal disease is the paramount condition causing the strong smell of exhaled air. In pathologic periodontal pockets there is massive presence of bacteria and

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overrepresentation of anaerobes, which are responsible for VSC production. Foreign bodies, tumors and presence of necrosis in airways as well as in the alimentary tract may also result in bad breath. None of the above conditions can be neglected.

Dental repositioning by massage is a good, safe and efficient method for management of occlusal problems. No it is not. Manipulation by the owner does not provide reliable and measurable effects, which will permanently reposition maloccluded teeth. In general light pressures of long duration are more important in orthodontic tooth movement [4]. In fact, it has been shown that a minimum of six hours of traction per day is required to achieve orthodontic movement. There are, however, some acceptable methods of improving occlusion by the use of toys, when the dog itself controls the strength of action (Fig. 1) [5].

Dental buds are impossible to reveal radiographically. After apposition and the maturation process the bud’s enamel and mineralized dentine can easily be seen on properly exposed dental radiographs. At the age of 10 weeks it is unlikely for the dental specialist to miss the presence of secondary teeth. If in doubt, another 2-3 weeks would be enough for the final evaluation (Fig. 2) [6].

“Everything was normal and then yesterday those teeth suddenly were found in front of the bite”. A sudden, non-traumatic occurrence of malocclusion is impossible. Therefore the evaluation of the bite must fulfill several criteria. The

Fig. 1 Example of an orthodontic device playing as passive appliance to correct linguoverted mandibular canines.

Fig. 2 Radiograph of the teeth buds present at the age of 10 weeks in swiss shepherd puppy.

Fig. 3a Front view of the incisors arch with the lack of “dental interlock” between incisors. Bouvier des Flandres 16 months old.

Fig. 3b Lateral view of the same dog showing excursion of the upper and lower incisors backward and forward respectively.
statement above usually refers to incisors and the problem of anterior cross-bite. Normally in scissor bite, the maxillary incisors arch is wider than the mandibular one and when the jaws are closed, the maxillary incisors are positioned outwardly [7]. In this position they somehow control the mandibular arch. This phenomenon is called “dental interlock” The forces against dental interlock are caused by tongue and upper lip [4]. If there is no dental interlock, the forces would gradually change the natural position [8]. Sometimes dental interlock disappears due to attrition or abrasion. Then one can observe malocclusion appearing in an adult dog which has not experienced any trauma (Fig. 3a,b).

The bite is normal when the incisors are in the proper position. The position of incisors is only part of the bite evaluation. Clinical examination of the occlusion performed in a conscious dog (this fact is crucial for an adequate evaluation) consist of 6 steps. The first is the evaluation of the skull symmetry and every quadrant of the mouth. Secondly, the TMJs mobility and movement. Thirdly, evaluating (when the jaws are closed) the incisor teeth (upper and lower) relations. Fourth, fifth and sixth steps are to evaluate the canine, premolars and molar teeth relations [9]. The most reliable reference point in the mouth is the relationship of the canines [8]. Considering only the position of the incisors, eliminates 5 of the 6 steps in proper evaluation.

The head in some breeds grows for 3 years, therefore the final bite evaluation should be performed at this age. There is no scientific proof for this assertion. Skull development and ankylosis of numerous sutures joining the maxillofacial part of the skull are independent processes. Some of the sutures disappear at the age of 10-15 years (e.g. sutura zygomaticoxillaris or sutura frontomaxillaris) [10] but it does not mean that the development of those bones lasts that long.

Missing teeth and malocclusions need not influence the choice of breeding stock in a particular breed. Of course it must. The list of tolerated problems in pedigree dogs which will be passed on to future generations should be revised and updated (Fig. 4a,b) [11,12].

Certain breeds (e.g. Bullterriers or American staffordshire terriers) do not perceive pain. The physiological mechanisms and response to stimulus in different breeds are the same. There is no proof or information that perception of pain may be different [13,14]. The individual analysis of the stimulus in CNS (Central Nervous System) and body reaction for pain surely may be different among different individuals in species as well as in certain breeds. It has much more to do with acquired character and mentality behavioral predisposition of the individual than features of the breed.

Old pets cannot have anesthesia. This is actually more a prejudice than a myth. The worst aspect of this issue is that it has been propagated by veterinarians who decide not to perform surgical procedures in old patients. In fact, studies have shown that if the patient is overall healthy (cardiothoracic, renal, hepatic systems) there is no increase in anesthetic risk in a geriatric patient. There is no doubt the geriatric anesthesia is more complex, but still the golden standards are the same as for younger patients. Certain relations between oral health and age are important: older dogs tend to have more gingival disease and dental calculus which increases the risk of anesthetic complications.

Fig. 4a Chinese crested dog with malocclusion and numerous missing teeth due to hereditary ectodermal defect. Fig. 4b Radiograph of the same dog.

Fig. 5 Anesthetic assistance while oral examination performed at Penn University.
and systemic condition are good reasons for referring cardiac or renal patients for comprehensive oral health assessment and treatment (COHAT) which aims at removing from the oral cavity the sources of pain and infection. The risk of anesthesia is balanced by potential significant improvement of life in the sick patient. (Fig. 5) [15].

Broken teeth do not hurt. Delta fibers present in dentine canaliculi recognize sharp acute pain right after exposure of the enamel. Even when the pulp chamber is not exposed, and only an enamel defect has occurred - the stimuli are transmitted into CNS. The character of pain is somatic and the lack of intervention leads to inflammatory response which causes chronic pain (different fibers are responsible for recognition and transmission of chronic pain), the risk of infection grows because of communication between pulp chamber and the external environment. And last but not least the pain memory constitutes this sensation and the effectiveness of preemptive analgesia may be limited to only the pain caused by surgical trauma [13].

If a dog/cat is eating it cannot have oral pain. Living in a group makes the behavioural rules simple and influences the position in this group. Showing signs of discomfort, pain and weakness may jeopardize the hierarchy of the group. The second instinct which involves the goal „to survive” also plays a role in the fact of eating and drinking even if oral pain exists (Fig. 6a,b) [16].

Persistent deciduous teeth are not a problem. Yes they are a problem. Changing the dentition is an unavoidable process in diphyodontic creatures. An ideal situation is when all 28 deciduous teeth in puppies and 26 in kittens are substituted by their respectively 42 and 30 permanent successors. This process should be finished at the age of 7 months after which the oral cavity should have complete permanent dentition. All remaining deciduous teeth are persistent unless their successors are missing. Leaving the persistent deciduous tooth forces the permanent one to erupt in an abnormal location. Two teeth occupying the same space disturbs the development of the gingival sulcus and leads to early periodontal disease (Fig. 7) [17].

Brushing the teeth is not necessary. This myth is caused by the reflection: that wild animals do not brush their teeth and survive. The most important contra-argument for this opinion is the fact that nutritional habits and meals differ a lot between domestic and wildlife carnivores. Another point is the difference of the lifespan in wildlife and domestic individuals. (Fig. 7)

Fig. 6a 12 years old mixbred male castrated with severe periodontitis. Still eating and drinking.
Fig. 6b The same dog 10 days after COHAT. Significant improvement of the life comfort and appearance too.

Fig. 7 Yorkshire terrier 12 months old. Persistent deciduous teeth causing: malocclusion (mesial drift of upper canine and linguoversion of lower canine) and gingivitis due to accumulation of the plaque and dental deposits.
Oral problems, particularly trauma, undoubtedly affects carnivores in their natural habitat as reported in literature [18,19]. Brushing the teeth influences the amount of dental plaque which is the major pathogenic factor in periodontal disease (Fig. 8) [20].

**Calculus is the best indicator of oral health.** The author received this information from contacts in the USA and only one comment which could sound reasonable occurs: the microflora which is a normal phenomenon in the oral cavity produces dental plaque on daily basis, which is controlled by occlusion, diet and habits. The equilibrium between production of the deposits and their removal while chewing is dynamic. Therefore one can say: the presence of dental deposits is common, but it is certainly not the sign of oral health status [2].

**Radical oncologic surgery is unethical.** This can be assessed regarding the quality of life of the animal and its welfare state. Surely pain, infection, inability to breath, eat and drink are reasons to perform different stages of surgical treatment in oral tumors. Sometimes it is palliation and sometimes, if the growth and tumor biology allows - it is radical surgery. How far we can go and how far we should go is the surgeon’s dilemma, and all aspects, including a presentation of all pros and cons, should be discussed with the owner in detail before the procedure is initiated. There is no doubt that radical surgery mutilates the patient, but the goal is to save the patient’s life. From the surgeon’s point of view, leaving a suffering animal without help and assistance is unethical. Oncologic surgery records present many patients that survive for a long time after massive surgery and, according to the owner’s feedback seem to be quite comfortable. However, every case should be treated individually and give a simple clear answer regarding what is the best management of the large oral tumors is impossible (Fig. 9).

**Resorptive lesions in cats are a self curing condition.** Contemporary knowledge of tooth resorption does not allow for this statement. One study has shown improvement of TR in cats after administration of alendronate – a drug which limits the activity of the osteoclasts. However, the results of the study are at present too preliminary to allow a conclusion as to the curative effect of the drug on TR [21]. TRs histologically appear as being in resorative and reparative phases simultaneously. However, the disease is progressive and continues until complete resorption of the affected tooth (Fig. 10) [22].

**Locking of the jaws occurs in pitbull terriers when they bite and it makes them really dangerous.** Presumably the origin of this prejudice is based on the fact that the fighting dog with high level of self confidence is not willing to release its prey. There is no explanation or physiological cause of the bite blockage after biting. Problems with mouth opening can occur due to ankylosic diseases of the temporo-mandibular joint, in tetanus condition or in some other conditions. The so called “locked jaw syndrome” is the problem of inability to close or open the mouth and it is widely discussed in the literature [23].

**Home care is a substitute for regular professional examination and treatment.** This is simply not true as only a professional examination performed under general anesthesia by an experienced veterinary dentist followed by appropriate radiographic evaluation gives an opportunity to reveal the vast
The majority of oral pathologies. Otherwise a significant number of problems will be missed [24].

A heart murmur requires antibiotic protocol before oral prophylaxis. The use of antibiotics as preoperative procedure is under discussion since the problem of antibiotic resistance has become serious and more frequent. In cardiovascular context it is recommended to perform COHAT (see above) in qualified and stable cardiac patients as it is significant relief from chronic pain and infection. The heart murmur itself however is not an indication for antibiotic therapy. These indications are: immune deficiency, severe infection with the risk of massive bacteriaemia, systemic diseases which influence immune system (e.g. diabetes. Studies comparing the use of clindamycin and chlorhexidine prior to dental scaling measured that single lavage of oral cavity by 0.2% chlorhexidine reduces population of oral microbials and prevents bacteriemia [25].

Truth

Oral health influences systemic conditions. Alimentary tract, airways and blood circulation are the distribution means of the oral pathogenic bacteria in the whole organism. Oral infections may cause a general inflammatory response or metastatic abscess [26].

Numerous procedures and/or situations should require pre-surgical oral health assessment and treatment. Pregnancy, diseases like diabetes, immunodeficiency disorders and also clear surgical procedures as prosthetic, orthopaedic and ophthalmologic are several important examples[27].

Radiography is a necessary part of oral examination. Without radiography it is impossible to evaluate the periodontium or periapical tissue or to perform appropriate endodontic, orthodontic, periodontal treatment. All surgical procedures performed without pre-op and post-op x-rays brings a high risk of iatrogenic complications and misdiagnosis.

The evaluation of occlusion takes into account several important criteria. These include: shape and symmetry of the skull, temporo-mandibular joint (TMJ) function, and finally the position and number of the teeth. The position of the maxilla and mandible is controlled by the muscles, thus it is important to examine the occlusion when the patient is awake. Relaxed muscles may not properly express the accurate relations of the jaws. The thorough bite evaluation requires paying attention to all criteria and is not limited just to the incisors arch or the position of the canines.

The tongue pushes the mandibular incisor teeth forward while the upper lip places pressure on the incisive bone ventrally. 'Dental interlock' controls this phenomenon. If the mandibular canines are linguoverted they cannot maintain the diastema between the third incisor and upper canine. Eventually the diastema becomes obliterated (Fig. 11) [28].

The cause of persistent deciduous teeth may be their malposition as well as the malocclusion of permanent teeth erupting. The mechanism of correct eruption is complex and relies on many factors (Fig. 12) [4,17].

Until the somatic development of the animal is completed, changes in occlusion may be observed. Reliable evaluation of occlusion must be performed at an appropriate age (usually 9-10 months in small breeds 10-12 months in medium breeds and 12-14 months in large breeds [29].

The skeletal characteristics of malocclusion are regarded as hereditary and therefore it is strongly advised that affected individuals should not be treated unless they are altered [29].

Complete dentition in the mouth of dogs consists of 42 teeth. Acceptance of missing dentition may lead to the establishment of this problem in the population.
Interceptive orthodontics in deciduous dentition (if properly performed) can diminish the risk of certain malocclusions [29].

Orthodontic work should be followed by position retention which can last for half of the amount of time it took for the tooth to reach the desired position [30,31].

Malocclusion, particularly in cases with traumatic consequences, requires immediate intervention. Often it may be solved by surgical and endodontic means, provided the result removes trauma (Fig. 13) [29].

Ethics

Every dog and cat is entitled to have a functional, healthy and comfortable bite, but not every animal will have the perfect bite [32]. This statement gives the veterinary dentist the right to treat malocclusions, missing teeth, and some facial abnormalities in good faith if it will not be used for fulfilling the kennel club requirement for show-dogs. We face continuous progress of technology, modern methods utilized in cosmetic surgery and repairing maxillofacial deformities. Therefore it is important to follow the ethical considerations which necessarily limit performing those procedures but surely influence the license for reproduction of these patients.

All efforts in orthodontics are to prevent trauma pain and discomfort and not to improve the image of the patient [9,29,32].

Numerous anesthetics are to be considered before an orthodontic treatment plan is accepted. Therefore, only high standard anesthetic procedures are accepted for such a treatment plan.

Many oral problems are proven to be genetically based and therefore hereditary. Due to this fact, selective criteria should include the breed predisposition to oral problems [8].

The dental procedures performed in pedigree dogs should be recorded in detail and attached to the rest of the animals’ documents [8].

To prevent the perpetuation of hereditary malocclusion the neutering of affected animals should be strongly advised.

The scissor bite in a mesaticephalic dog with proper relations of its dentition and all criteria of bite evaluation shall be presented prior to discussion about malocclusion. In scissor bite, the maxillary incisors overlap the mandibular incisors whose incisal edge rests on upper incisors cingulum. The mandibular canine fits evenly between the maxillary third incisor and canine. The upper premolars interdigitate with the lower premolars starting rostrally with the first mandibular premolar. The crowns of maxillary and mandibular molars occlude with each other.

References


[29] Surgeon TW. Indications planning and ethical considerations for orthodontic treatment. Pesq Vet Bras. 2007 Apr 27; Suppl 27.

