Disorders of **DENTAL HARD TISSUES** in Dogs

Brook A. Niemiec, DVM, FAVD, Diplomate AVDC
Southern California Veterinary Dental Specialties,
San Diego, California

Many types of hard tissue pathology affect small animal veterinary patients. Many of these are caused by a form of trauma, but acidic degradation, infection, and genetics also play a role.

**ENAMEL HYPOCALCIFICATION/HYPOPLASIA**

Enamel is a very thin (< 1 mm) material on the surface of the tooth crown. Ameloblast cells initiate enamel formation, and are only present during this process. Enamel is created prior to tooth eruption and cannot be naturally repaired after teeth erupt.

**Causes & Development**

Hypoplasia/hypocalcification results from disruption of normal enamel development.

- **Enamel hypocalcification** occurs when normal amounts of enamel are produced, but are hypomineralized, making the enamel softer than normal.
- **Enamel hypoplasia** occurs when the enamel produced is hard, but thin and deficient in amount.

Enamel hypocalcification can result from trauma to an unerupted tooth, which can affect one or several adjacent teeth, and is the most common acquired cause. While this defect may originate from external trauma, it is often associated with extraction of deciduous teeth.

Enamel hypoplasia may result from a hereditary condition known as amelogenesis imperfecta, which results when a decreased amount of enamel matrix is applied to teeth during development. In these cases, nearly all teeth, and all surfaces, are involved.

A severe systemic infectious (for example, canine distemper virus infection that occurs in puppies before the teeth have erupted) or nutritional condition may also result in improper enamel production.

**Clinical Signs & Diagnosis**

Common signs of enamel hypocalcification/hypoplasia are listed in Table 1. These signs emphasize that prompt therapy is critical to the health of the patient.

Prior to therapy, dental radiographs must be exposed to evaluate whether tooth nonvitality or root malformation (Figure 1) is present.

**Treatment Options**

Treatment goals include:

- Removing sensitivity
- Avoiding endodontic infection by occluding the dentinal tubules
- Smoothing the tooth to decrease plaque accumulation.

**TABLE 1. Clinical Signs of Enamel Defects**

- Affected areas stained tan to dark brown; may appear pitted and rough
- Hard tooth surface, not soft or sticky
- Exposed dentin as areas of malformed enamel exfoliate; this exposure results in significant patient discomfort
- Stained dentin, since it is porous
- Increased plaque retention due to tooth roughness (results in early periodontal disease)
- Potential infection via the dentinal tubules
Composite restoration is the most effective way to accomplish these goals (Figure 3), and it also improves tooth appearance. However, this therapy only provides a small amount of strength.

Crown therapy can be performed if damage is severe and the client is interested in a permanent correction (Figure 4).

Smoothing and bonded sealant application can be considered for minor areas of disease or nonstrategic teeth, and in patients whose owners have financial concerns (Figure 5). For more information on this procedure, see Bonded Sealant Application for Crown Fractures (July/August 2011), available at tvpjournal.com.

Extraction may be performed, but it is generally not recommended.

PERTINENT TOOTH ANATOMY

ENAMEL
The tooth crown is protected by a thin shell of enamel. Enamel thickness in cats and dogs varies from approximately 0.1 mm to 1 mm.

PULP
Tooth pulp is a soft tissue that contains blood vessels, nerves (sensory only), and other types of cells, including odontoblasts, fibroblasts, and fibrocytes. Blood enters the tooth through the apical delta, along with the nerve bundles.

DENTIN
Dentin is arranged in tubules—these extend from the pulp to either the area where dentin and enamel meet (dentinoenamel junction) or the root where cementum and enamel meet (cementoenamel junction).

Dental tubules are filled with fluid and odontoblastic tendrils, which are cytoplasmic extensions of odontoblasts. These tubules are major pathways for diffusion of material across dentin—a concept known as dentin permeability.

DENTIN–PULP COMPLEX
Due to the interdependent relationship between pulp and dentin, these two tissues are best considered as one entity: the dentin–pulp complex. Pulp and dentin function as one unit because odontoblasts, which line the pulp cavity wall, project their extensions into dentin. Also, odontoblasts are responsible for formation of dentin. In turn, pulp tissue is dependent on dentin for protection.
CARIES\textsuperscript{1,2,9}

Caries (in humans, commonly called “cavities”) occur when acid dissolves the hard structures of the teeth. Reports on prevalence vary widely, which may be due to overdiagnosis of discolored surfaces,\textsuperscript{18} but caries are fairly rare in dogs and almost unheard of in cats. A study that evaluated dogs seen at a veterinary dental referral facility found a prevalence of 5.3\%.\textsuperscript{19}

Causes & Development

Caries lesions begin in areas where food becomes trapped (Table 2); bacterial digestion of the food produces acid, which initiates the lesion.\textsuperscript{20} Therefore, home care can help avoid these lesions.

Development of caries can ultimately affect the endodontic system.
1. The initial lesion—a surface decalcification of the enamel—is caused by a drop in pH.
2. Demineralization follows the direction of the enamel rods.
3. Eventually, caries breaks through the enamel and invades the dentin. Once this occurs, the lesion expands laterally fairly quickly, as dentin is less mineralized than enamel.
4. Once dentin is destroyed, the unsupported enamel will collapse, expanding the lesion.
5. These lesions can progress into the endodontic system, resulting in pain and infection.

<table>
<thead>
<tr>
<th>TABLE 2. Locations of Dental Caries</th>
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<tbody>
<tr>
<td>• Occlusal surface of maxillary first molars (most common)</td>
</tr>
<tr>
<td>• Occlusal surfaces of other molars and maxillary fourth premolars</td>
</tr>
<tr>
<td>• Deep developmental grooves</td>
</tr>
<tr>
<td>• Sides of tooth, especially contact surfaces (smooth surface caries)</td>
</tr>
<tr>
<td>• Tooth roots</td>
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</tbody>
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Clinical Signs & Diagnosis

Outwardly, caries appear as a discolored tooth defect (Figure 6). Discoloration is usually brown to black, but can be white very early in development. Early lesions can mimic wear, and are best diagnosed by tactile feel of the defect with a sharp explorer (Figure 7). Healthy tooth structure is solid, whereas caries is soft and sticky. When penetrating the caries, the explorer will experience “tug back.”

Prior to therapy, dental radiographs must be exposed to determine the size of the defect and evaluate tooth vitality. Caries appear as radiolucent areas (Figure 8).

Treatment Options

Evidence of endodontic disease:
• Root canal therapy is required prior to restoration.
• Crowns are recommended since damage is likely significant—creating teeth susceptible to fractures.
• Extraction can also be considered.

Early to moderately advanced caries:
• Removal of all diseased tooth structures is required prior to restoration.
• Composite resin restoration is generally the best choice (Figure 9).
• Amalgam, however, is also a valid option.

Lesions at or below the gingival margin:
• Glass ionomer restoration is most likely the best treatment.\textsuperscript{21}

DISCOLORED (INTRINSICALLY STAINED) TEETH

Intrinsically stained teeth are discolored teeth in which the abnormal color stems from inside the tooth, specifically the dentin–pulp complex.

Causes & Development\textsuperscript{1,5}

In dogs, intrinsic staining most often results from blunt trauma of sufficient force to cause pulp hemorrhage, but not enough to fracture the tooth. However, in other dogs, there may be no history of trauma and discoloration occurred for other reasons. For exam-

Figure 6. Caries lesion on the occlusal surface of the right maxillary first molar (109).

Figure 7. Abrasion on the occlusal surface of right maxillary first molar (109); note the dark staining, which mimics a caries. When touched with a sharp explorer, this lesion was hard, in contrast to the sticky feeling with “tug back” expected with caries.

Figure 8. Classic radiographic appearance of caries lesion on distal aspect of left mandibular first molar.

Figure 9. Composite restoration of left maxillary first molar (209)—(A) Pre-operative picture demonstrating caries, and (B) postoperative picture of composite restoration.
ple, another possible, but unlikely cause, is tetracycline use in very young patients; most, if not all teeth, become discolored (yellow/brown).

Intrinsic staining results when extravasated blood is forced into the dentinal tubules and then degenerates:
1. A tooth stained by degenerating blood products following pulp hemorrhage appears pink immediately after the injury, eventually becoming darker brown or gray (Figure 10).
2. Although dental pulp can heal after injury, the vast majority of discolored teeth are nonvital.
3. Once the tooth becomes nonvital, it often becomes infected via the blood supply, in a process known as *anacboresis*.
4. Once the tooth becomes infected, it acts as a bacterial fortress, allowing bacteria to create periapical infection, which may spread to the entire body.
5. Intrinsically stained teeth can also cause clinical abscessation.

The only exceptions to the above process are:
- **Young patients**: The large endodontic system and good blood supply of these patients allow them to recover from the inflammatory pulpitis, and the tooth returns to normal color in a few weeks. If this does not occur, the tooth should be considered nonvital.
- **Patients with only discolored cusps** (rest of the tooth unaffected) (Figure 11): These teeth should be radiographed and transilluminated; if both results are normal, the tooth should be monitored.

**Clinical Signs & Diagnosis**

Clinical observation is generally diagnostic.

**Transillumination** should be performed if there is any question whether the tooth is discolored (Figure 12).

*Note:* As pulp cavity diameter decreases with age, transillumination becomes less reliable and eventually impossible.

**Dental radiographs** should also be exposed to determine the condition of the roots:
- **Nonvitality** is indicated by change in width of the endodontic space or periapical lucency (Figure 13).
- **Pulp necrosis** is indicated by a larger root canal diameter than the contralateral tooth.
- **Generalized pulpitis** is indicated by a smaller diameter root canal space than the contralateral tooth.
- **Periapical lucency** is evidence of endodontic infection, causing bony resorption.

Normal radiographs do *not* indicate that the tooth is alive and not infected, but some will argue that lack of radiographic changes indicates the...
Both of these lesions are created by chronic contact with a hard object.  
- **Abrasion** is caused by a tooth wearing against something foreign.  
- **Attrition** is caused by tooth-tooth contact.  
  **Attrition** is caused by a malocclusion in which the opposing teeth are in contact, which may be due to:  
  - A *level* bite—a mild class III malocclusion (undershot) and most common cause (**Figure 15**)
  - **Maxillary third incisors** creating attrition on the mandibular canines (**Figure 16**)
  - **Improper reduction** of a maxillofacial fracture.  
  **Abrasion** can be caused by many different objects but, in general, is due to very aggressive chewing, which is more common in large breed dogs.  
  - **Chronic chewing on toys**, such as tennis balls, wears down the canines and premolars (**Figure 17**).  
  - **Chronic chewing on the skin** due to allergic dermatologic disease typically wears down the canines and incisors, often to the gum line (**Figure 18**).  

A 2001 study by Hale demonstrated that only 40% of intrinsically stained teeth had radiographic signs of endodontic disease. However, when physically examined, 92.7% were nonvital and infected. In our experience (over 1000 cases), **all** discolored teeth have been nonvital and infected.

**Treatment Options**

Discolored teeth (with the exceptions noted earlier) are generally irreversibly inflamed or necrotic. Once the endodontic system becomes nonvital and/or infected, the tooth must be removed. There are 2 main options for removal.

- **Root canal therapy** is the treatment of choice for larger teeth, such as canines and carnassial teeth (**Figure 14**).  
- **Extraction** is a viable alternative for small teeth, such as incisors and premolars; however, root canal therapy is also indicated if the client wishes to save the tooth.

**ABRASION/ATTRITION**

These lesions are similar to uncomplicated crown fractures; however, they result from long-term wearing of the tooth as opposed to a 1-time traumatic event.
• Chewing on a chain link fence damages the distal aspect of the canines (Figure 19).

Treatment Options
All teeth with attrition or abrasion should be radiographed to ensure tooth vitality. If there are signs of endodontic disease (clinical or radiographic), required treatment is root canal therapy or extraction.

Treatment of dental attrition is generally not necessary—unless there is evidence of endodontic disease (clinical or radiographic)—because slowly exposed dentin generally becomes sclerotic and subsequently impervious to pain and bacterial invasion.

• Slight odontoplasty with a fine diamond or white stone bur should be performed to alleviate any contact, followed by application of a bonded sealant.

• Extraction or odontoplasty with restorative or endodontic treatment should be performed before restoration of deep defects, such as those on the mandibular canines caused by maxillary third incisors, because the malocclusion has reached equilibrium—any restorative creates new contact and discomfort.

Treatment of dental abrasion, such as restorative therapy, is not generally indicated because slow progression of abrasion typically results in sclerotic dentin.

Behavior modification is the most important form of therapy, and may include:
• Supervising play time
• Changing toys to less abrasive ones
• Modifying the cage
• Treating allergic dermatitis.

Cast metal crowns can help “build up” canine teeth if behavior modification is not possible and the client wishes to protect the tooth and provide more tooth surface (Figure 20).

Full-coverage cast metal crowns are strongly recommended to strengthen teeth in dogs that have significant damage on the distal aspect due to fence chewing, as they are in great danger of fracturing if not protected (Figure 21). I have had excellent long-term success with this technique in military and police dogs. However, some veterinarians favor a three-quarter crown to decrease the amount of tooth structure removed. 26

IN SUMMARY
Any time dentin is exposed, tooth sensitivity and inflammation results. In addition, teeth with direct pulp exposure are initially exceedingly painful, and then invariably become infected. These teeth can and should be restored.

Common options for restoration include bonded sealants, composite restoration, and crowns. Most of these techniques are easy to learn, taught at certain training centers, and inexpensive to initiate in practice. When the pulp is involved (including discoloration), treatment is directed at removing the infected root canal system, which can be accomplished by root canal therapy or extraction.

Client education is the key to gaining acceptance of treatment recommendations. The article Dental Services: Good Medicine for Patients & Practices (September/October 2011), available at tvpjournal.com, discusses the client education process with regard to dentistry.

FIGURE CREDITS
Figure 1: Reprinted with permission from Small Animal Dental, Oral, and Maxillofacial Disease—A Colour Handbook, Niemiec BA (ed). London: Manson, 2010.


Figures 12 and 13: Courtesy Dr. Jerzy Gawor.


Brook A. Niemiec, DVM, FAVD, Diplomate AVDC, is chief of staff of Southern California Veterinary Dental Specialties, with offices in San Diego and Murrieta, California, and Las Vegas, Nevada.
References