

# FRACTURED TEETH

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Fractured upper 4<sup>th</sup> premolar tooth



Fractured lower canine tooth

Dogs fracture (break) teeth in many ways. The 2 most commonly fractured teeth are the canines (fangs) and the upper 4<sup>th</sup> premolar (the largest of the upper chewing teeth in the back of the mouth), with the incisors (the small teeth in the very front) coming in a close third place. The lower 1<sup>st</sup> molar (the largest of the lower chewing teeth in the back of the mouth) and smaller premolars on the sides can also be fractured.

Fractured canine teeth and incisors usually result from either an impact with a solid object, from tugging behavior, or from fights. These teeth are also more likely to fracture when they have been weakened or worn by previous damage caused by a malocclusion (where the teeth do not fit together properly, causing excessive wear & pressure), developmental defects in the structure of the tooth (e.g. enamel hypoplasia), or by inappropriate chewing behaviors such as chewing on a fence or cage.

Fractured upper 4<sup>th</sup> premolars, lower 1<sup>st</sup> molars, and smaller premolars are generally caused by chewing hard or inappropriate objects such as real bones, rocks, horse/cow hooves, antlers, and even some chew toys such as hard plastic or nylon bones or other hard toys. Fractures of the upper 4<sup>th</sup> premolars are one of the most common types of dental fractures that I see in dogs. In addition, fractured teeth with pulp exposure are sometimes not recognized to be a serious problem by veterinarians who have not been trained in dentistry. Taking a “watch and see what happens” approach to a fractured tooth is not appropriate, because the majority of problems caused by these teeth is not visible to the naked eye.

**THE SHORT SCENARIO** – Teeth with complicated fractures (i.e. fractures with exposed pulp) are infected, by definition. The mouth is loaded with bacteria, just waiting for an opportunity like a fractured tooth, so there is always bacterial contamination, resulting in infected pulp. Infected pulp becomes inflamed, and eventually becomes necrotic (dies). Necrotic tissues putrefy. The bacteria in the tooth form a biofilm, which protects the bacteria from things like the immune system and from antibiotics, and the tooth becomes a chronic source of bacterial invasion into the tissues around the root and into the bloodstream itself. This results in inflammation, infection, or damage that can affect many organ systems. Proactive action is needed when a tooth has exposure of the pulp.

### **Tooth Anatomy:**

A tooth consists of 3 parts: enamel, dentin, and pulp. The enamel is the tough non-porous mineral outer shell of the tooth that is normally the only part of the tooth that can be seen. The dentin is a more porous bony material that lies beneath the enamel, and is softer than enamel. The dentin has microscopic tubules present, which normally allow nutrients to diffuse from the pulp into the dentin, to keep the tooth structures alive and healthy. In addition, the dentinal tubules contain some of the nerve endings that supply sensation to the teeth. Animals have approximately 30,000-50,000 dentinal tubules per square millimeter of tooth surface\*, which is about twice the amount than humans have. Therefore, when the dentin is exposed to the mouth, there is significant sensitivity present. In addition, the tubules are large enough to potentially allow bacteria to work their way into the tooth, and into the pulp itself. The pulp consists of the blood vessels and nerves that supply both nutrients and sensation to the tooth.

### **Consequences of tooth fracture:**

If the tooth fracture has resulted in exposure of the pulp, and the time between fracture and dental treatment is greater than 48 hours, or is unknown, then it is safe to assume that bacteria have invaded the pulp tissue. When bacteria invade the pulp tissue, it results in inflammation of the pulp tissue, called pulpitis. The pulpitis and bacterial infection cause irreversible damage and swelling of the pulp, which ultimately results in the death of the pulp tissue (pulp necrosis), and therefore, death of the tooth. This process may or may not result in abscess formation. It always becomes a source of chronic inflammation, as well as allowing chronic leakage of bacteria and the necrotic contents of the pulp into the system. This can result in damage to multiple organ systems, including the liver, kidneys, and heart. The rare circumstance wherein the tooth fracture has occurred less than 48 hours before treatment is addressed below.

If the tooth fracture is greater than 48 hours old, the tooth must either be treated with root canal therapy to preserve the tooth, or be surgically extracted. When root canal therapy is performed on a fractured tooth, I either make an opening in the enamel to allow access to the inside of the tooth or, in some cases, use the fracture site itself to access the inside of the tooth. Then, I remove the necrotic pulp from inside the tooth, clean and disinfect the empty root canal, seal the end of the root, and fill the root canal with an inert filling material. Then, I place a surface composite restoration, or “filling” in the tooth, to seal it from further exposure to the bacteria in the oral cavity.



X-ray of upper 4<sup>th</sup> premolar after root canal procedure

### **Root canal therapy vs. extraction:**

The advantages of root canal therapy are that this tooth is kept as a functional tooth in the mouth, maintains a more normal structure and appearance to the mouth, and the procedure causes much less pain and damage to the oral structures than surgical extraction, resulting in more rapid recovery. For example, working dogs can go back to their duties 1-3 days after a root canal procedure, whereas after surgical extraction, it can take 1-2 weeks of recovery.

The disadvantages of root canal therapy are that there is typically increased cost of root canal therapy compared to extraction, follow-up dental imaging (x-rays and Cone-Beam CT) are required, and that there is a small

chance of failure. With root canal therapy, anesthetized dental imaging should be performed 9-12 months after the root canal procedure in most cases, to make sure the procedure was successful.

Regarding extraction, the advantages are that it is a one step procedure and that it is usually less expensive than root canal therapy (some difficult to extract teeth may be costly extractions, however). The disadvantages are that the pet loses the functional and structural benefits of the affected tooth and there is more pain and tissue damage caused by surgical extraction, resulting in a longer recovery time. There are also multiple complications that can result from an extraction procedure. The complications can include fracture of the surrounding bone, excessive bleeding, nerve damage, perforation into the nasal cavity, air embolism, weakening of the mandible (lower jaw), broken root tips resulting in persistent chronic inflammation or infection, root tips being dislodged into the nasal cavity or vascular channel in the mandible, and others not listed here.

When considering the option of root canal therapy vs. extraction, several factors must be considered. The first is the functional importance of the affected tooth. Certain teeth have more critical functions than others. The large premolars and molars are important chewing teeth, the canines help with gripping large objects, and the incisors are used for fine gripping. The second is the structural importance of the affected tooth. The large upper chewing tooth (4<sup>th</sup> premolar) works in conjunction with the large lower chewing tooth (1<sup>st</sup> molar) to assist in side-to-side stabilization of the jaw. The canines also assist in side-to-side stabilization of the jaw. The upper canines provide facial structure and keep the upper lips out of the mouth and away from being accidentally bitten. The lower canines make up more than half of the structure of the jaw in the area they are, and also hold the tongue in the center of the mouth and away from being accidentally bitten. Some teeth, including the canine teeth and incisors, also have esthetic benefits, since there is a noticeable change in the pet's appearance when these teeth are missing.

In some cases, complicating factors such as periodontal disease, young teeth that have not fully developed their root structure, or fractures that extensively compromise the tooth structure are present. These factors make the long-term prognosis for the affected tooth poorer. In some of these cases, root canal therapy may not an option, due to the increased chance of failure of the procedure, and extraction may be the recommended option.

#### **Failure of a root canal procedure:**

There is a very small number of root canal procedures that will not be successful, even in the hands of an experienced veterinary dental practitioner. Typically, the failure is either due to microscopic fissures around the composite restoration through which bacteria enter the tooth, from damage cause by other factors like periodontal disease, from residual bacteria in the root structure, or from the patient subsequently breaking off more of the tooth structure.

The most common cause of failure in a chewing tooth, like the upper 4<sup>th</sup> premolar or lower 1<sup>st</sup> molar, is the pet fracturing the tooth again. This is caused by the same behavior that caused the fracture in the first place...chewing hard objects. If the cause of the fractured tooth can be identified and eliminated in the future, then the chance of success increases. Hard objects that commonly cause tooth fracture include: hard plastic or nylon bones, real bones, antlers, horse/cow hooves, rocks, etc. The potential for re-fracture is reduced by crown placement (see below) and/or avoiding chewing on these types of hard objects.

Failure of a root canal procedure in a canine tooth can also be due to any of the above causes. However, re-fracture of a canine tooth is less likely than for a chewing tooth. The reason for this is that the fractured tooth is now shorter than the other canine teeth in the mouth. Since fracture of a canine tooth is usually due to a side impact, tugging, etc., the shorter tooth will be much more resistant to fracture. In fact, when one canine tooth is shortened relative to the others, it puts most of the stress on the normal-length canine teeth. This makes trauma more likely to fracture the intact canines, rather than the shortened canine tooth. If a canine tooth has been extracted, this increases the risk of fracturing the remaining canine teeth even more. This is yet another benefit of root canal over extraction.

If a root canal procedure fails, additional treatment will be needed at additional cost. The treatment could include: re-cleaning and filling of the root canal, a surgical procedure called an apicoectomy, or surgical extraction. The appropriate procedure will be determined by the health of the tooth, the amount of additional damage, and other factors.

### **Crown placement:**

If root canal therapy is performed, the final stage of the procedure is the “restoration” of the tooth. This is done either with composite (or “filling,” as described above) or with crown placement. Crown placement is an optional procedure, and is not an automatic necessity, unlike with many human root canal procedures. Crown placement is the procedure of fabricating and placement of an artificial tooth covering over the existing tooth structure.

### **Composite restoration vs. crown restoration**

#### **1) Composite restoration.**



Upper 4<sup>th</sup> premolar with composite



Upper canine with composite

Composite restoration is the placement of a filling in the opening through which the root canal procedure was performed. The filling seals the root canal of the tooth to help prevent bacteria in the mouth from invading the tooth and causing the root canal procedure to fail.

The advantages of a composite filling are that it is done in a single procedure at the time of the root canal therapy, and it does not add significant cost to the root canal therapy. The disadvantages of a composite filling are that it does not restore any of the damaged tooth structure, there is a slightly higher possibility of the root canal failing due to microscopic leaks in the filling (which allows bacteria to migrate into the tooth), and that it does not add any strength to the tooth structure.

#### **2) Crown placement.**



Upper 4<sup>th</sup> premolar with crown

Crown placement is the process of cementing a fabricated metal or ceramic artificial tooth covering over the existing tooth structure. The process of placing a crown is a 2-step procedure. The first step is performed at the

same time as the root canal therapy. It involves shaping the tooth to receive the crown and taking impressions of the tooth that will be used by the dental laboratory to fabricate a metal or ceramic crown specifically made to fit that tooth. In the second anesthetic procedure, which is performed about 2-3 weeks later, the fabricated crown is cemented in place and any final adjustments are made.

Crown placement is most beneficial for teeth that will be subject to significant compressive forces, such as chewing teeth. Therefore, crown placement is recommended in many cases where an upper 4<sup>th</sup> premolar or lower 1<sup>st</sup> molar has been fractured. The risk of re-fracture of the chewing teeth is generally higher than the risk of re-fracture of the canine teeth after root canal therapy. In addition, crown placement increases the strength and resistance to re-fracture of the chewing teeth. In contrast, I feel that it generally does not significantly increase the resistance to re-fracture of the canine teeth.

The advantages of crown placement are that it re-creates the tooth form and function and that it has the least likely chance of the root canal procedure failing due to microscopic leakage of bacteria into the tooth. The disadvantages of crown placement are that it requires 2 separate anesthetic procedures to perform and that it is more expensive than simple composite restoration.

It is important to note that there is a small chance that crowns can fail, as well. In some cases, the crown can loosen or come off of the tooth. However, failure is more commonly associated with re-fracture of the tooth below where the crown is placed, with the crown still attached to the tooth. In my experience the risk of this type of re-fracture is higher with crowns on canine teeth than on the large chewing teeth. The other rare occurrence is for the pet to develop an allergic reaction to the metals in the crown. This may not develop until years after crown placement. In the unlikely event that this should occur, the crown would need to be removed, and possibly replaced by crown made from a different material.

One feature of crown placement in animals that could be considered either an advantage or disadvantage is that most crowns used in animals are made of metal. Therefore, the fabricated crown that is placed is silver in color, rather than the color of a natural tooth. The porcelain crowns that are routinely used in people are too susceptible to breakage when used in animals, and therefore carry a higher risk of failure in the long run. There are ceramic materials available now that have the benefit of being tooth colored while still being resistant to wear, even in a dog's mouth.

#### **Special Circumstance: Fresh tooth fracture (less than 48 hours old):**

If the timing of the tooth fracture is known for certain (not the time that the fracture was discovered, but the time that it actually occurred) and the patient can be safely anesthetized within 48 hours of the occurrence of the fracture, there is a procedure called vital pulp therapy that may be an option. In this procedure, a small amount of the pulp is removed, a pulp dressing is placed, and a composite filling is placed in the tooth. The goal is to maintain the living tissues inside the tooth in a healthy state. If a vital pulp therapy is performed within 48 hours of tooth fracture, there is a reasonable (mid 80s percent) chance of success. However, if the procedure is performed after 48 hours, the success rate drops dramatically. If vital pulp therapy is performed, then follow up anesthetized dental imaging (x-rays and Cone-Beam CT) should be performed every 6-9 months for at least 2-3 years to confirm the success of the procedure. The procedure may fail as much as 2-3 years after it was performed. If the procedure should fail, then root canal therapy or extraction would need to be performed.

In most cases where there is a fractured tooth, even if the fracture is fresh, root canal therapy is preferred over vital pulp therapy as the first line of treatment. Root canal therapy has a significantly higher success rate than vital pulp therapy for fractured teeth, even if the fracture is relatively fresh. In addition, there is less follow up with root canal therapy (one anesthetized follow up imaging in 9-12 months) than with vital pulp therapy (multiple anesthetized follow up imaging procedures over a 2 to 3-year period).

The exception to the recommendation for root canal procedure is with a young dog (less than 1 year) that has fractured a tooth. At this age, the internal tooth structure has often not fully developed. In this circumstance,

vital pulp therapy can provide additional time for the tooth structure to develop. If/when the procedure fails, the tooth structure is generally more mature, and a root canal procedure is performed at a later date.



Tooth after vital pulp therapy



X-ray of tooth at left

### **Tooth fracture without pulp exposure:**

If the tooth fracture has resulted in dentin exposure only, with no pulp exposure, the exposed dentin will also result in problems. The dentinal tubules contain fluid, and also some of the nerve endings in the tooth. Dentin exposure results in desiccation of the dentinal tubules and exposure of nerve endings. There are about 30,000-50,000 dentinal tubules per square millimeter of tooth structure\* (one square millimeter is about the size of this symbol: ° ). The result is a tooth that is more sensitive to heat, cold, pressure, drying, and certain foods.

There is also potential for bacteria to invade the pulp via the exposed dentinal tubules. One study showed that there is approximately a 25% chance that a fracture that has not resulted in pulp exposure will result in disease or infection of the pulp\*. If bacteria invade the pulp tissue, it results in inflammation of the pulp tissue, called pulpitis. This causes irreversible damage and swelling of the pulp, which ultimately results in the death of the pulp tissue (pulp necrosis). If this happens, the result is the same as if the tooth had been fractured with exposure of the pulp. If this has occurred, then the only two treatment options are either root canal therapy or extraction (as discussed above).

One way to determine if a tooth has become non-vital (dead) is by performing dental imaging to evaluate the affected tooth. Non-vital teeth often have internal changes or evidence of bony damage around the root tip seen on imaging. Dental imaging can only be performed under anesthesia in animals. Therefore, there is no way to know if an affected tooth is living or not, until the treatment procedure is performed. In addition, a tooth that has recently become infected or dead will not show any changes on imaging yet, because these changes take time (as much as 6-12 months) to appear. One other method that can help determine if a tooth is living or not is called “transillumination.” Transillumination is a procedure where a bright light is passed through the tooth. Light passes through living pulp differently than it does through dead pulp. If bacterial invasion has already occurred, but the tooth has not become devitalized or abscessed yet, then this will still occur even if the tooth is treated. If bacteria have invaded the tooth, but are not causing problems yet, then there is no way to detect this. If a tooth fracture does not result in pulp exposure, and the tooth is not treated, AND if bacteria have not entered the pulp, then the dentinal tubules will naturally mineralize and close, resulting in a comfortable, healthy tooth. It is not certain how long this takes, but it likely takes 6-12 months. Therefore, in tooth fractures that are over a year old, with no pulp exposure and no disease evident on imaging, it is likely that no treatment is needed.

### **Treatment options for fracture without pulp exposure:**

When a tooth has been fractured and there is no direct pulp exposure, it initially results in sensitivity.

In the case of exposed dentin in a tooth that appears to be living, there are four treatment options:

1) **Crown placement** (see notes on crown placement above). This is the best option to both protect the tooth and restore full function. It is usually only recommended for major chewing teeth that have lost a large amount of structure without exposing the pulp.



2) **Composite restoration.** This is a very effective approach for teeth that do not have extensive structural damage. Composite restoration is the placement of a filling material over the defect in the tooth. This will permanently seal the exposed dentinal tubules and will both eliminate sensitivity as well as the chance of bacterial invasion into the tooth. It has the added bonus of making the tooth appear normal, by physically covering up the defect. It is also important to note that the composite restoration can be broken off, just like tooth enamel itself, if the pet has inappropriate chewing behavior (such as chewing rocks or a cage door).

3) **Dentin bonding.** This is the application of a sealing material to the exposed dentin, in order to seal the ends of the dentinal tubules. The goal is to reduce sensitivity and reduce the chance of bacterial invasion through the dentinal tubules. This is simpler and less expensive than composite restoration, but does not improve the appearance of the tooth.

4) If the fracture is greater than 1 year old, the tooth appears to be a living tooth, and there are no abnormal changes on imaging, then it is likely that no treatment is needed.

### **ATTRITION & ABRASION:**

Attrition results from long-term tooth wear due to abnormal contact with another tooth. The most common cause for attrition is when a pet has a malocclusion, where the teeth do not fit together normally.

Abrasion happens when a tooth is worn down from long-term or aggressive chewing on hard or abrasive objects. This type of wear can be caused by chewing on rocks, hard toys, or even soft toys that have an abrasive surface, like tennis balls, burlap toys, and some other types of cloth toys. Abrasion can also be caused by dogs that chew on their coat or feet, which is common when dogs have allergies. With abrasion that happens over a long period of time, the abraded teeth will often continue to be living teeth. When that happens, the pulp inside of the tooth recedes and is replaced by a type of protective bony material called tertiary dentin. This is similar to the process by which dentinal tubules re-mineralize when there has been a fracture with dentin exposure. When the teeth are worn down far enough, we can see the tertiary dentin as a yellow, tan, light brown, or dark brown circle on the center of the worn tooth surface. These teeth are typically still living, healthy teeth, and no treatment is needed. However, sometimes when a dog chews persistently or aggressively on an object, the pressure or the friction associated with the chewing can cause the pulp in that tooth to become swollen. When that happens, the pulp subsequently dies. These teeth may or may not become discolored (ivory, tan, pink, purple, brown, or gray). Some dead teeth do not become discolored at all, though. When a dead tooth has subsequent abrasion, the body is no longer able to make the protective tertiary dentin. Then, when the tooth is worn down enough, the area of dead pulp becomes exposed to the mouth, and bacteria enter the tooth, causing a chronic infection in the tooth. Because the tooth is dead, most dogs do not show any evidence of being painful. However, the bacteria cause chronic inflammation around the tooth root and can enter the blood stream in large numbers, which can have effects on many different organ systems. When these dead teeth are worn down, the discolored circle on the worn surface of the tooth is usually very dark brown to black, and the opening to the pulp may or may not be visible. In most cases these teeth are confirmed to be non-living when dental imaging (x-rays and Cone-Beam CT) is performed, because they usually have an abnormal appearance on imaging. Any worn teeth that appear abnormal on imaging or have a visible opening to the pulp need to be treated with either root canal or extraction, similar to teeth that have fractures with pulp exposure. Abrasion of the teeth is a progressive problem, if the behavior that caused the abrasion in the first place is allowed to continue. If the cause of the abrasion can be identified and removed, the future of the teeth is more promising. If the cause of the abrasion cannot be controlled or removed, as in the case where abrasion is caused by chewing due to allergies, it is important to continue monitoring in the future for additional teeth that become non-living.

### **Procedure costs:**

Exact estimate for the cost of treatment for a fractured tooth will vary depending upon the specific tooth that is affected, the treatment option chosen, and other circumstances surrounding the procedure. In addition, a pet with a fractured tooth often has other dental problems as well. The cost of the procedure will also depend upon the totality of the dental work that needs to be performed. There are many dental problems that cannot be visualized in an awake animal, and are not detected until the pet is under anesthesia. Estimates are given on a case-by-case basis, and there is always potential for change in the total cost, based on anesthetized exam and imaging.

\*References available on request.

Additional information can be found online at the web sites of:

The American Veterinary Dental College - <https://avdc.org/animal-owner-resources/>

Veterinary Partner web site - <http://www.veterinarypartner.com>

Veterinary Oral Health Council - <http://www.vohc.org>

Animal Dental Specialists of Nevada - [www.AnimalDentalNV.com](http://www.AnimalDentalNV.com)

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