EMERGENCY MANAGEMENT OF CROWN TRAUMA

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Crown fracture in dogs and cats is a relatively common problem secondary to blunt trauma to the oral cavity. An uncomplicated crown fracture involves the enamel and dentin but does not cause pulpal exposure. A complicated crown fracture involves enamel and dentin, and exposes the pulp.

Trauma which does not cause crown fracture may deleterious affect the tooth. Concussive and luxation injuries may disrupt the vascular supply to the tooth causing pulpitis and devitalization of the tooth.

Anatomy and Pulpal Pathophysiology

The inner part of the crown is referred to as the pulp chamber. The root canal extends from the pulp chamber apically in each root. The pulp occupies the pulp chamber and root canal(s). The pulp is composed of soft connective, vascular, and nerve tissue. Cell types within the pulp include odontoblasts, fibroblasts, fibrocytes, collagen fibers, elastic fibers, blood vessels, and nerves. Odontoblasts are the cells responsible for the formation of dentin, which comprises the majority of the mature tooth structure.

Pulpitis is the inflammation of the pulp which causes clinical signs of pain. Pulpitis may be reversible, however in veterinary medicine pulpitis is most commonly diagnosed after it has caused pulp death and a nonvital tooth. The sequelae associated with pulpitis is dependent upon the type of trauma or inciting cause, whether the crown is fractured exposing the pulp, and the maturity of the tooth. Regardless of etiology, the pulp undergoes inflammation resulting in pulp edema and an inflammatory cellular response. A negative inflammatory cycle may occur with continued small artery perfusion, edema, and venule obstruction related to the pulp’s location in a confined space. Increased vascular pressures within the tooth stimulate pain receptors. A large pulp chamber and canal(s) of the immature tooth enable a greater incidence of reversible pulpitis, especially if the apex is open. This more favorable prognosis is based on greater space to accommodate edema and elevated pressures. Pulp cavities in the older dog and cat are constricted and narrow diminishing the tooth’s ability to favorably respond to inflammation.

Crown fracture which causes pulp exposure not only incites pulpal inflammation, but also exposes the pulp to the oral environment. Healing does not occur spontaneously. Pulp necrosis results with bacterial infection playing a dominant role. Similar to inflammation in any wound, hemorrhage and an appropriate inflammatory response is followed by fibrin formation. Pulpal hyperplasia (pulp polyp) similar to
granulation tissue may form or necrosis and pulpal abscessation may occur within days of the injury. Pulp hyperplasia is indicative of maintained vascular supply and an appropriate inflammatory response associated with a more recent injury.

Complicated Crown Fracture

Treatments for a complicated crown fracture include root canal therapy or vital pulpotomy (pulp capping). Each procedure would be followed by crown restoration. However, the procedures themselves are different and dependent upon the patient’s history and oral examination.

Vital pulpotomy is performed when the crown fracture and subsequent pulp exposure are recent. The two primary prognosticating factors associated with recommending this procedure are maintained vascular supply to the pulp via the root apex or apices, and minimal bacterial contamination along the pulp canal(s). Therefore, recent injuries in teeth of relatively young dogs are the best candidates for vital pulpotomy. Older patients with constricted pulp cavities may be best treated with root canal therapy even if the injury is recent since functional vascular supply is so critical for this procedure to be successful. If vital pulpotomy fails, the tooth then becomes a candidate for root canal therapy or extraction. Therefore, if the owner is aware of the complications and possibility of a second procedure, vital pulpotomy is a viable treatment option even in the older patient. Obviously, since bacterial contamination is likely based on duration of pulp exposure, the procedure should be performed as soon as possible. A set time frame is not advised since a young patient with prolonged exposure (days) of the pulp and moderate to severe contamination may respond as well as an older patient seen within hours with a minimally contaminated pulp. Experimental studies have shown that exposed pulp remains viable up to 7 days following pulp exposure secondary to fracture. Pulp inflammation generally extends approximately 2 mm from the fracture site. Bacterial contamination and pulp necrosis occurs when food and debris are plugged into the pulp preventing the self-cleaning effects of saliva. Although each case will be unique and must be evaluated independently, many patients with complicated crown fracture will be candidates for vital pulpotomy if the fracture orientation allows self-cleaning and the pulp appears “healthy”. Unfortunately, in veterinary medicine the actual time of the trauma is not known with patients often presented with evidence of chronic pulp exposure. These patients are not candidates for vital pulpotomy. Treatment (root canal therapy or extraction) is still necessary, but not urgent.

Vital pulpotomy is a procedure whereby the coronal aspect of the pulp is removed. It is hoped that the most contaminated area of the pulp is included in the resected pulp. The remaining pulp is treated to maintain its vascular supply and tooth viability. The remaining vascular supply will be responsible for healing of the pulp at the resection site and for continued maturation of the tooth, including dentin development if necessary. A thorough periodontal examination should be performed to determine the presence of moderate to severe periodontal disease which may jeopardize tooth
maintenance. Radiographs of the tooth should be taken to verify no evidence of substantial periodontitis, periapical infection, or root fracture which would change the treatment plan. Supporting bone should be evaluated for alveolar fracture which may require treatment.

The procedure begins by rinsing the fractured crown and surrounding periodontal tissues with 0.2% chlorhexidine. Sterile instruments and dental burs are used for the remainder of the procedure. A sterile glove may be placed over the fractured crown. A small incision in the glove will expose the crown while providing a relatively aseptic surgical field. A sterile round or pear-shaped diamond bur similar to the size of the root canal is placed in a high-speed handpiece using aseptic technique. The pulp is removed using the bur under water irrigation for a distance of approximately 7 mm. The result should be removal of the pulp and hemorrhage from the crown fracture site. Hemostasis may be achieved with a moistened sterile paper point placed in the pulp canal/chamber or a sterile paper point with calcium hydroxide applied to its pointed end and placed directly on the pulp. If the pulp fails to hemorrhage, the tooth is nonvital and should be extracted or receive root canal therapy. If hemorrhage persists after 5 minutes, further pulpotomy may be required to remove additional inflamed pulp; or, pulp filaments remain at the bur site and require removal using a spoon excavator. The viable pulp is treated with a 2-3 mm layer of calcium hydroxide after hemostasis is achieved. A cement base is applied after the calcium hydroxide has hardened followed by crown restoration with a composite material. Radiographs of the tooth should be performed semiannually for 2-3 years postoperatively, and then annually for the remainder of the patient’s life. During the follow-up period, the crown should not become painful or discolored. Radiographs should show an area of calcification (dentin bridge) at the pulp-restoration interface and no evidence of periapical pathosis demarcated by osteolysis at the tooth apex. Dentin development should be the same as the contralateral, matching tooth. A prosthetic crown may be manufactured and applied after clinical and radiographic evidence of pulpal healing.

Chronic crown fractures do not require immediate treatment. Chronic crown fractures may have gross food and debris within the fracture site. Odor from the tooth may be fetid. Dental radiographs may show evidence of periapical pathosis indicative of a nonvital tooth. Periodontally disease-free, nonvital teeth are candidates for root canal therapy or extraction.

**Tooth Luxation**

Extrusive luxation is the peripheral displacement or partial avulsion of the tooth. The canine teeth are most commonly affected. The apex of the tooth is displaced and alveolar bone is often fractured. The force and direction of impact determines the direction of the luxation. Radiographs of the tooth should be performed to determine if there is root fracture, and to assess the amount of fractured alveolar bone. Radiographs will show an increased width of the periodontal space at the apical aspect of the tooth in
cases of extrusive luxation. This type of injury often results in pulp necrosis in the mature tooth. The immature tooth may develop partial pulp necrosis limited to the coronal aspect due to an open apex and greater vascular supply apically. If revascularization of the pulp occurs, or if the pulp survives, there is a high incidence of negative pulp changes. These changes are secondary to a revascularization process which may contribute to internal root resorption followed by deposition of calcified tissue (dentin) which causes partial or complete pulp canal obliteration. Therefore, owners should be advised that the first step of treatment is to reduce the luxation, with a subsequent treatment plan usually including root canal therapy. If the owner declines the possibility of root canal therapy, tooth extraction should be offered.

Treatment of the mature tooth begins with reduction using digital pressure as soon as possible. A splinting procedure is performed following tooth reduction in order to prevent further pulp damage and to stabilize the tooth during the initial healing period.

Splint application should: be immediate and directly applied; atraumatic; restore normal tooth position; provide adequate fixation; not interfere with occlusion; not damage soft tissues; and, not interfere with endodontic therapy. Acrylic splints fulfill the aforementioned requirements. The procedure begins by thorough cleansing of the crown after the tooth has been reduced. Anchorage teeth (usually the opposite canine tooth) are also cleaned. The tooth surface which will receive the acrylic is acid etched with 40% phosphoric acid gel for 1 minute followed by rinsing with water. This procedure results in 30-50 micron porosities in the enamel which will aid adherence of the acrylic to the enamel. Effective acid etching results in a tooth surface which has a “chalky” appearance. The tooth is dried and the acrylic is applied. Acrylic is applied to the affected tooth and the anchorage tooth with a bridge formed across the mandibular symphyseal mucosa or hard palate mucosa. Orthopedic wire (22g) between the teeth may be applied first to support the acrylic. A cold-curing acrylic (Pro-temp Garant-ESPE) is recommended to reduce injury which may be related to acrylics which produce an exothermic reaction. The owner should be instructed in oral hygiene since warm water lavage around the splint will minimize food accumulation and subsequent gingivitis. The splint should be maintained for 2-3 weeks; 3-4 weeks if there is associated alveolar fracture. The tooth should be monitored for signs of pulp necrosis which should be evident 2 weeks following injury. Root canal therapy is recommended as soon as color changes indicative of pulp necrosis are confirmed and the tooth has been stabilized (2 weeks).

Exarticulation or complete luxation is diagnosed when the tooth is totally displaced out of the socket or is attached only by gingiva. The periodontal ligament is usually split with part remaining with the tooth and part attached to the alveolus. Preservation of the cells of the periodontal ligament is critical for successful replantation. Cell viability is greatly reduced after 2 hrs of exposure to air. Therefore, dogs and cats with complete tooth avulsion should be examined immediately. The owner should be instructed not to wash the tooth in any way; simply place it in milk, which serves as an excellent emergency transport medium. Rinsing the tooth with tap water is detrimental to periodontal cells. The clinician should remove gross debris by rinsing the tooth with
saline. The tooth and alveolus should not be debrided. The clot should not be removed from the alveolus. It will be displaced once the tooth is replanted. The maneuver is performed digitally with the patient heavily sedated. A splint is applied as described previously and maintained for 10 days-2 weeks. The vascular supply to the tooth is severed secondary to the injury necessitating root canal therapy 2 weeks following replantation in order to prevent the development of inflammatory root resorption.

**Concussive Injury**

Pulpitis independent of crown fracture is usually secondary to blunt trauma directly to the tooth. A thorough oral examination and radiographs should be performed to document that the tooth is in normal position and has not undergone intrusive trauma. This type of trauma forces the tooth in an apical direction, driving the tooth into the bone and is a form of tooth luxation.

Perceptible tooth movement is not present. Pulp injury is diagnosed based on color changes within the visible crown. These color changes occur within hours of the trauma indicating to the clinician that the viability of the pulp is in jeopardy. Initially, hemoglobin break-down products enter the dentin tubules and enamel. As the hemocomponents degenerate, the initial pinkish color appears grey-blue through the enamel. This color change to grey-blue occurs approximately 2-weeks after pulp injury and indicates pulp necrosis. Tooth sensitivity to percussion, if present earlier, usually is absent by this time due to necrosis of nervous tissues.

Radiographic evidence of periapical pathosis supports the diagnosis of pulp necrosis. A periapical osteolytic area may be noted as early as 2-3 weeks post-trauma. Generally, discolored teeth which have pulp necrosis will have evidence of periapical pathosis within 1-2 months of the injury.

Client education is important when examining the polytrauma patient with concussive injury to the crown. The incidence of pulp necrosis following this type of trauma is high and the owner should have the tooth monitored several times during the first 4-6 weeks post-trauma. Root canal therapy or extraction are treatment options for pulpitis and pulp necrosis without crown fracture.

**Uncomplicated Fracture**

Uncomplicated crown fractures should receive radiographs to confirm the absence of concomitant root fracture. This injury may be treated by simply smoothing the fractured crown surface with a diamond finishing bur. Application of a fluoride gel may be applied to decrease pain which may be associated with acute dentin exposure.

**Recommended Reading**