Endodontic treatment of a dental fracture with pulp exposure of the right upper fourth premolar in a canine: case report

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ABSTRACT

Dental fractures represent a specific set of injuries affecting the tooth and/or its supporting structures. In veterinary dentistry, crown fractures with pulp chamber exposure are among the most common endodontic injuries. While tooth extraction is one possible treatment for these cases, root canal therapy offers a more specialized and less invasive alternative, particularly suitable for horizontal supragingival tooth fractures. This report presents the case of a 5-year-old male Cavalier King Charles Spaniel, neutered, evaluated and treated by the Amico Dental veterinary team in Brazil. During the clinical examination, mild gingivitis and a dental fracture involving enamel, dentin, and pulp of tooth 108 were observed. Radiographic examination revealed signs of periapical bone lysis, suggesting a localized infection. This case emphasizes the significance of dental fractures and presents endodontic treatment through root canal obturation as an alternative to tooth extraction in cases of pulp exposure.

Keywords: pulp exposure, root canal, treatment**,** dental fracture.

Tratamiento endodóntico en fractura dentaria con exposición pulpar de cuarto premolar superior derecho en un canino: reporte de caso

RESUMEN

Las fracturas dentales son un conjunto de lesiones específicas que afectan al diente y/o a sus estructuras de soporte. En la odontología veterinaria, la fractura de la corona dental con exposición de la cámara pulpar es una de las lesiones endodónticas más comunes. Aunque la extracción dental es uno de los tratamientos que se puede utilizar para estos casos, el tratamiento del canal radicular es un procedimiento más especializado y menos invasivo, por lo cual es una alternativa viable para fracturas supragingivales horizontales del diente. Este trabajo reporta el caso de un canino macho de raza Cavalier King Charles

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Spaniel, castrado y de 5 años, evaluado y tratado por el equipo veterinario Amico Dental en Brasil. Durante el examen clínico, se observó gingivitis leve y una fractura dental que afectaba el esmalte, la dentina y la pulpa en el diente 108. El examen radiográfico mostró indicios de lisis ósea periapical, lo que sugirió una posible infección localizada. Este caso subraya la importancia de las fracturas dentales y presenta el tratamiento endodóntico mediante la restauración radicular con la técnica de obturación del canal pulpar como una opción frente a la extracción dental en casos de exposición pulpar.
Palabras clave: canal radicular, exposición pulpar, fractura dental, tratamiento.

INTRODUCTION

Dental fractures in canine species, commonly referred to as traumatic dentoalveolar injuries (TDI), are defined, according to Soukup *et al.* (2015), as a specific set of injuries affecting the tooth (either the crown or root) and/or its supporting structures, such as the periodontal ligament and alveolar bone, due to direct traumatic force. The classification system for dental fractures used in many veterinary studies is based on a human classification system that identifies 14 types of dentoalveolar injuries and categorizes dental fractures according to the tissues affected (Soukup *et al.* 2015). Within this framework, crown fractures with pulp chamber exposure or enamel-dentin-pulp fractures are the most common endodontic injuries in veterinary dentistry (Jucan *et al.* 2023).

Tooth extraction is recommended in cases of vertical or subgingival root fractures, while root canal treatment and restoration are indicated for horizontal supragingival fractures (Bladowski *et al.* 2013). It is worth noting that this classification applies when the affected part is above the gumline, potentially involving both the tooth crown and supporting structures. Although dental extraction is an option for teeth affected by endodontic disease, a more specialized and less invasive procedure, such as endodontic therapy, offers an alternative for preserving the structure and functionality of the tooth (Carvalho *et al.* 2024).

Endodontic treatment encompasses procedures designed to remove damaged or infected dental pulp and seal the tooth's canals. This approach helps prevent infections and maintains the health of the tooth and alveolar bone. In applying this technique to animals, well-defined procedural principles have been developed, primarily by adapting endodontic methods from human dentistry to the specific anatomy of canine and feline teeth (Girard *et al.* 2006).

Over the years, studies have been conducted on different types of dog teeth to assess the success rate of therapy based on the number of roots treated (Adrian *et al.* 2022; Strom *et al.* 2018). Some of these studies indicate that, due to the more complex morphology of multirooted teeth, outcomes tend to be less favorable. However, in dogs specifically, various studies have shown that root canal therapy is consistently successful (Adrian *et al.* 2022; Kuntsi–Vaattovaara *et al.* 2002). When strict criteria were applied, the success rate ranged from 69% to 71%. In contrast, when *flexible criteria* (a combination of success and absence of evidence of failure) were used, higher success rates were observed, reaching between 95% and 96% (Jucan *et al.* 2023).

This case report aims to highlight the significance of pulp disease and presents an alternative to tooth extraction in cases of dental fractures with pulp canal exposure, detailing the technique and feasibility of endodontic obturation.

CASE DESCRIPTION

Anamnesis

A 5-year-old neutered male Cavalier King Charles Spaniel weighing 10.4 kg was presented at an authorized veterinary clinic in the region. After an initial evaluation, the dog was referred to the Amico Dentale team in São Paulo, Brazil. According to the owner, the dog had sustained a dental fracture over a year prior without receiving treatment. The owner reported no symptoms of dysphagia or behavioral changes, suggesting that the fracture might have resulted from the dog's habit of biting the door.

Clinical examination findings

A general physical examination indicated that all physiological parameters were within normal limits. However, the examination revealed mild gingivitis and a supragingival horizontal dental fracture with pulp exposure in tooth 108 (figure 1), identified according to the modified Triadan system (Floyd 1991).

Diagnostic aids

For preoperative assessments, a complete blood count, chest radiograph, Doppler echocardiogram, and electrocardiogram were requested, all of which showed no relevant clinical abnormalities. Subsequently, the team performed a comprehensive radiographic study of the oral cavity using intraoral projections of the entire dental arch. The primary objective was to detect any periodontal bone defects in both the affected tooth and the apparently healthy teeth. Two radiographic techniques were employed: the parallel technique

FIGURE 1. Right maxillary fourth premolar (108) with crown–root fracture, showing pulp exposure (yellow arrow).

Source: own elaboration.

(P technique), where the film is positioned parallel to the teeth and the X-ray beam is directed perpendicular to both the tooth planes and the film, forming a 90° angle; and the bisecting angle technique (B technique), where the radiographic film is placed perpendicular to the tooth (90° to the tooth plane). The X-ray beam is then directed towards the film at a 45° angle, bisecting the angle between the film and the tooth (Carvalho *et al.* 2019).

These two comprehensive radiographic techniques allow visualization of the teeth and surrounding structures in both humans (Yen & Yeung 2023) and in dogs and cats (Hennet & Girard 2005; Nepomuceno *et al.* 2013; Lobprise & Dodd 2019). In tooth 108, a chip fracture of the dental crown with pulp exposure was observed, classified as a complicated enamel-dentin fracture with pulp involvement according to Soukup *et al.* (2015). Periapical bone lysis was also noted (figure 2). No other abnormalities were identified in the remaining teeth.

Based on radiographic findings and a detailed oral examination, a diagnosis of dental fracture with pulp exposure in the right maxillary fourth premolar (modified Triadan 108) was made, and endodontic obturation of the three roots was chosen as the optimal treatment option. This approach aimed to eliminate or significantly reduce the bacterial population in the non-vital pulp and to maintain or restore the health of the adjacent periodontal tissues.

Clinical procedure

On the day of the procedure, the patient underwent an 8-hour food fasting and a 2-hour liquid restriction. The dog was alert, with no signs of pain or discomfort,

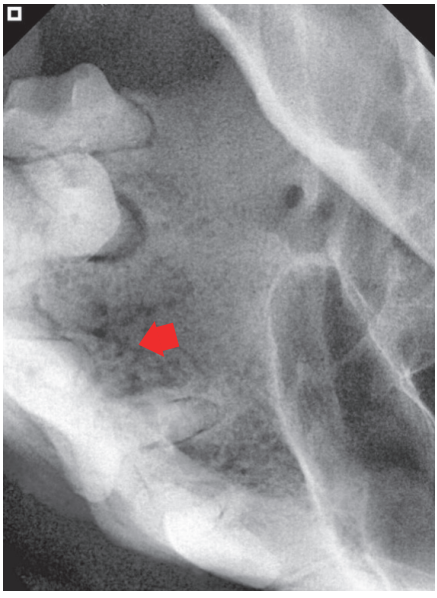

FIGURE 2. Right maxillary fourth premolar dental radiograph, using the bisecting angle technique. Periapical lysis of the alveolar bone is evident (red arrow).

Source: own elaboration.

showed cranial symmetry, and had normal submandibular lymph nodes upon palpation. During the specific oral examination (without sedation), the gingival mucosa appeared normocolored and hydrated. However, the patient exhibited grade II dental calculus across the dental arch, as classified by Lobprise and Dodd (2019), along with mild gingivitis in the premolars and molars, moderate halitosis, and pulp exposure in tooth 108.

The patient was taken to the operating room, where preanesthetic medication was administered with acepromazine at 0.02 mg/kg and methadone at 0.15 mg/kg, both intramuscularly. Next, the middle third of the right forearm was shaved, and the area was antiseptically prepared with gauze soaked in 70% alcohol. A 22-gauge catheter was inserted and secured in the cephalic vein for venous access. For anesthetic induction, propofol at 2 mg/kg combined with ketamine at 1 mg/kg was administered, followed by maintenance with inhaled isoflurane at 1.5%.

Surgical technique

The treatment followed the global dental guidelines of the World Small Animal Veterinary Association, as described by Niemiec *et al.* (2020). First, dental scaling (both mechanical and manual) was performed on all dental arches using an ultrasonic scaler. Next, coronal polishing was completed using a dental brush and prophylactic paste on a low-speed handpiece. The entire oral cavity was then rinsed with pressurized water using a three-way air-water syringe. Finally, topical antisepsis was applied with 0.12% chlorhexidine, and a local anesthetic block was performed using 2% lidocaine. To block the maxillary nerve, a 24-gauge needle was inserted into the pterygopalatine fossa, and 0.3 ml of 2% lidocaine was injected at a dose of 5 mg/kg.

The upper fourth premolar has three dental roots: mesial, palatal, and distal. To facilitate the procedure given the tooth's anatomy, endodontic access was made parallel to the long axis of the distal root of tooth 108. A 0.12% chlorhexidine spray was used to reduce contamination, and diamond-tipped burs attached to a high-speed motor were used for access, following the recommendations of Hennet and Girard (2005).

In line with the methods outlined in the literature (Lobprise & Dodd 2019; Girard *et al.* 2006; Hennet & Girard 2005), the pulp chamber was first aseptically cleaned with a 1% sodium hypochlorite solution due to its effectiveness in dissolving organic matter; this solution can be supplemented with coadjuvant solutions like Endo-PTC (León *et al.* 2003). For root canal exploration, a Hedstroem® endodontic file (H) number 15 was inserted through the access site to measure the distance between the entry point and the apex of the root (working length determination). An additional radiographic projection was taken using the bisecting angle technique (figure 4). The apparent tooth length, which measured 21 mm, was determined using a millimeter-calibrated endodontic ruler.

Before obturation, the canal was instrumented to enlarge the cervical portion, facilitating improved irrigation and disinfection of the area. The WaveOne Gold® reciprocating file system (Dentsply-Maillefer, Ballaigues, Switzerland) was used as described by Freitas *et al.* (2018) to remove debris, shape, and smooth the dentinal walls of the root canal through alternating clockwise and counterclockwise partial rotations. Initially, the WaveOne Gold Glider® file (#15.02) was used for

preliminary canal enlargement, followed by the WaveOne Gold Small® file (#20.07) for further shaping and dentin debris removal, and concluding with the WaveOne Gold Primary® file (#25.07) (figure 3). After each instrument change, the canal was irrigated with 1% sodium hypochlorite and dried with an absorbent paper point.

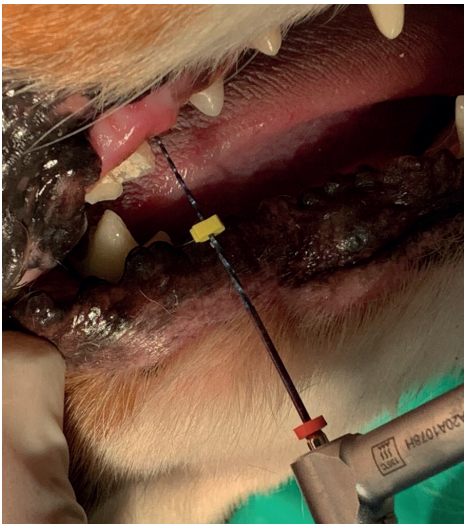

FIGURE 3. Distal root canal instrumentation of tooth 108 using WaveOne Gold Primary® reciprocating file system (25.07) coupled to a high-speed air turbine.

Source: own elaboration.

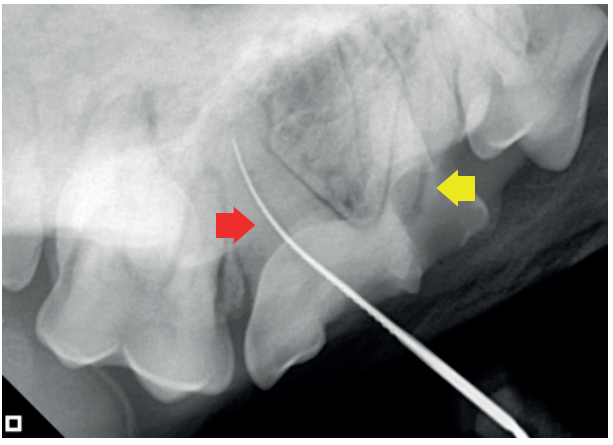

FIGURE 4. Tooth 108 dental radiograph, using the bisecting angle technique. The image shows the Hedstroem #15 endodontic file in the distal root canal (red arrow); the widening of the mesial root canal is also seen (yellow arrow).

Source: own elaboration.

A polymer-based filling cone (number 25 gutta-percha) was then inserted into the root canal, and an additional radiographic examination was performed to confirm that the cone had reached the actual working length. After verifying the filling of the root canal with gutta-percha, the sealing cement was placed in the canal alongside the gutta-percha cone. Upon confirming proper obturation, the canal was filled with a zinc oxide-eugenol-based restorative cement, and the gutta-percha was trimmed with a curette, applying pressure to the apical region. A vertical condenser was then used to compact the gutta-percha within the root canal.

The same technique was applied to access the pulp chamber, perform antisepsis, measure working length and fill the root canal with gutta-percha and dental cement in the mesial and palatal roots of tooth 108. An additional radiographic projection was taken using the bisecting angle technique (figure 5). To complete the procedure, a light-cured composite resin was applied using ultraviolet light (figure 6), and the oral cavity was thoroughly cleaned to remove any residual material, concluding the filling and restoration treatment (figure 7). A bolus of metronidazole at 15 mg/kg IV was administered, and the animal was monitored until recovery from anesthesia.

Following the procedure, the patient was admitted for monitoring and discharged the same day, with a follow-up appointment scheduled for 15 days later. The patient was prescribed dipyrone at 25 mg/kg every 8 hours for 5 days and tramadol hydrochloride at 4 mg/kg every 8 hours for 5 days due to the synergistic effect of these two medications. Additionally, a 0.12% chlorhexidine mouthwash spray was recommended twice daily for 7 days.

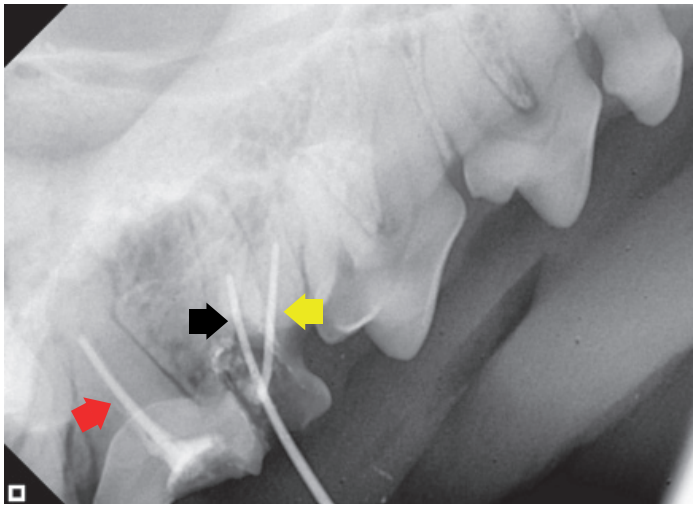

FIGURE 5. Tooth 108 dental radiograph, using the Clark technique, showing the completed filling of the mesial (yellow arrow) and distal roots (red arrow), as well as the filling of the palatal root canal with 21mm gutta-percha (black arrow).

Source: own elaboration.

FIGURE 6. Photopolymerization of composite resin (restoration) with ultraviolet light.

Source: own elaboration.

FIGURE 7. Tooth 108 post-restoration (yellow circle).

Source: own elaboration.

DISCUSSION

Dental fractures with pulp exposure provide a direct route for bacteria to invade the tooth's internal tissues, resulting in pain, inflammation, contamination, and infection, leading to endodontic disease (Campbell *et al.* 2016). Endodontic disease can progress to more severe pulp necrosis, potentially causing systemic complications in some cases (Jucan *et al.* 2023; Lobprise & Dodd 2019). In this case, the patient exhibited no signs of systemic infection; however, mild gingivitis was observed around the fractured tooth, and radiographs indicated localized bone lysis in the alveolar bone of the affected tooth, consistent with a localized infection.

According to Souza *et al.* (2018), one of the most common causes of endodontic injury in veterinary dentistry is the habit of chewing hard objects, as seen in this case. Unfortunately, animals with endodontic disease often suffer for extended periods before diagnosis and definitive treatment. Niemiec (2009) notes that most endodontic cases remain undiagnosed due to the absence of external signs other than a fractured or discolored tooth, as dogs and cats rarely display overt signs of oral pain or disease progression.

The diagnosis of dental fractures is crucial and begins with a thorough patient history, physical examination, and intraoral radiographs. It is essential to document all teeth radiographically for an accurate diagnosis of oral lesions; as this procedure requires general anesthesia, it should be properly integrated into dental treatments (Carvalho *et al.* 2019). Radiographic examination played a key role in this case, as it not only revealed typical endodontic disease findings such as an enlarged pulp chamber, periapical lysis, and crown fracture (Campbell *et al.* 2016), but also effectively guided the precise execution at each stage of the protocol, as described by Hennet and Girard (2005). This ensured correct instrumentation within the tooth during the operative phase and facilitated proper canal obturation, which was instrumental in achieving the high quality of the final procedural outcome.

The use of reciprocating instrumentation has become an advanced and effective solution for root canal preparation in endodontics. This method is notable for the use of a single disposable instrument, leading to reduced working time, decreased instrument requirements, and increased procedural safety (Freitas *et al.* 2018). Although these instruments are designed for single use, it is common for alternative files to be used to prepare multiple canals within the same tooth. This practice is especially prevalent in molars with three or four root canals, which present challenges due to the complexity of their anatomy (Kirchhoff *et al.* 2018).

The versatility of reciprocating instrumentation allows dental professionals to address difficult cases more effectively. However, it is crucial to follow recommended usage guidelines to ensure treatment quality and patient health. In summary, reciprocating instrumentation not only optimizes the endodontic process but also promotes a safer and more efficient approach in clinical practice.

The success of endodontic treatment largely depends on the thorough cleaning and obturation of the root canals (Tandir *et al.* 2024). However, the surgeon's skills, knowledge, and experience are indispensable. This treatment is performed in veterinary dentistry in an attempt to maintain periodontal and endodontic health in strategically important teeth

affected by pulp necrosis. The goal is to remove the infected or necrotic pulp while shaping, cleaning, and disinfecting the root canal, followed by obturation and restoration (Jucan *et al.* 2023).

The authors suggest that endodontic therapy should be initially considered for class IV dental fractures, a technique that has been extensively studied in recent years (Mareschi *et al.* 2020; Adrian *et al.* 2022; Lee *et al.* 2022). On the other hand, although Hennet and Girard (2005) recommend the use of prophylactic antimicrobial therapy prior to endodontic surgery, it was only administered during the intraoperative period in this case to reduce post-procedural bacteremia. According to Siqueira (2002), there is evidence that the infection site is not affected by systemic antibiotics, as they fail to reach and eliminate microorganisms in the root canals due to the lack of blood circulation in the exposed pulps. For this reason, antibiotic therapy was not used, and instead, the use of 0.12% chlorhexidine was prescribed postoperatively. In accordance with the study by Michelotto *et al.* (2008), 0.12% chlorhexidine was effective against both aerobic and strict anaerobic bacteria in the oral cavity.

It is worth noting that nonsteroidal anti-inflammatory drugs (NSAID) are recommended for both pain and inflammation in endodontic treatments (Hennet & Girard 2005). However, in this case, they were not prescribed. It would be interesting to use them in the postoperative phase to help maintain the viability of the tooth and its supporting and protective structures (gingiva, alveolar bone, and periodontal ligaments).

A significant limitation that persists across all areas of veterinary practice is that pet owners often fail to return for follow-up visits, which hinders the ability to assess medium- and long-term progress, as was the case in this study. Authors such as Jucan *et al.* (2023) recommend conducting radiographic follow-ups at least once a year for patients receiving endodontic treatment.

CONCLUSIONS

Radiographic studies are essential and fundamental in the diagnosis and treatment of dental diseases. However, intensive training is required for veterinarians to acquire and interpret radiographic projections clearly and efficiently to reach an accurate diagnosis. The root canal obturation technique described in this report followed the steps and recommendations outlined in the literature, resulting in a successful outcome. Therefore, it represents an excellent alternative to dental extraction. However, regular dental check-ups and follow-up care every six months are crucial to ensure favorable long-term outcomes.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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The surgical procedure was funded by the owner.

USE OF ARTIFICIAL INTELLIGENCE

The authors declare that no artificial intelligence was used in this study.

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