# Apical Infections of Cheek Teeth and Their Oral Extraction

Professor P. M. Dixon, MVB, PhD, MRCVS

Author's address: Division of Veterinary Clinical Studies, The University of Edinburgh, Easter Bush Veterinary Centre, Easter Bush, Midlothian, EH25 9RG Scotland.

## Aetiopathogenesis of Cheek Teeth Apical Infections

Apical (periapical) infections of cheek teeth (CT) are a major clinical problem, especially in younger horses, where the infection inevitably involves the supporting mandibular (Fig. 1) or maxillary bones (Fig. 2), or the overlying paranasal sinuses. The term *apical infection* is preferable to *tooth root infection* as these infections often occur in younger horses before any true roots (enamel-free apical areas) develop, although in adult horses, apical infections can also be accurately termed tooth root infections.

The cause(s) of CT periapical infections have recently been examined,[1,2] and in just a minority of cases that have been studied, has the infection reached the tooth apex from the oral cavity by an obvious direct physical route.

The potential routes of infection of cheek teeth apices are:

A) An extension of periodontal disease, such as with a displaced or supernumerary CT or a diastema.

B) Pulpar exposure on the occlusal surface due to an imbalance between occlusal surface wear and the deposition of secondary dentine can allow pulpar, and later apical infection. However, *secondary* pulpar exposure will eventually develop in any tooth with an apical infection, as the apical infection will kill the pulp (and thus the odontoblasts) in one or more of the pulp horns, and normal occlusal wear will eventually expose the pulp at the tooth's occlusal surface.

C) In maxillary CT, food accumulation and fermentation deep in defects in infundibular cement (around the central vascular channel) can cause infundibular cemental caries. However, it is relatively rare for cemental caries to extend through the enamel walls of the infundibulum and then penetrate through the adjacent dentine to cause pulpar infection.

D) Following traumatic and idiopathic CT fractures, bacteria from the oral cavity will track down the fracture site into a pulp horn, leading to apical infection. However, as noted elsewhere in these proceedings (PM Dixon - idiopathic cheek teeth fractures), most horses can control such pulpar exposures or at least keep any pulpar and/or apical infections subclinical with such fractures. In just a minority of idiopathic CT fractures, clinical apical infection will occur.

E) Bony distensions of the mandible and maxillae, known as "eruption cysts", may develop beneath the apices of permanent 07 and 08 CT, when they erupt at circa 3 and 4 years of age, respectively. These "eruption cysts" can cause considerable focal distension and thinning of the overlying bone. In the lower CT, apical infection commonly involves the 07s and 08s and often develops within 12 months of tooth eruption.[3] This infection may be predisposed to by vertical impaction of these erupting teeth. The route of the infection into the apex in these and most other cases of apical infection is believed to be hematogenous (reverse lymphatic spread is also possible), with bacteria lodging and multiplying in actively developing pulp that may be inflamed due to the impaction. Current evidence indicates that the majority of CT apical infections are due to this mechanism that is termed *anachoresis*, i.e. blood or lymphatic borne bacterial infection of a possibly devitalised apical pulp – e.g. predisposed to by vertical impaction of these teeth[2].

**Figure 1. This young horse has a ventral swelling of the rostral aspect of its left hemimandible due to an apical infection of 306.**

**Figure 2. This horse has a persistent rostral maxillary swelling and sinus tract due to apical infection of 108. Apical infections of this tooth can also drain into the rostral maxillary sinus, causing nasal discharge without a facial swelling or tract.**

If the apical infection progresses, the pulp and calcified dental tissues adjacent to the apices will become infected (Fig. 3). At this stage, removal of the infected pulp horns, infected calcified dental tissues and also of the infected periodontal tissues is required. Endodontic (root canal) therapy, or more usually dental extraction need to be performed. The clinical signs of apical infection include bony and soft tissue swellings and possibly a discharging tract on the mandible (Fig. 1) or rostral maxillary area (Fig. 2). Unilateral nasal discharge is caused by paranasal sinusitis secondary to apical infection of a caudal maxillary CT and sometimes by infection a rostral maxillary CT that discharge into the nasal cavity.

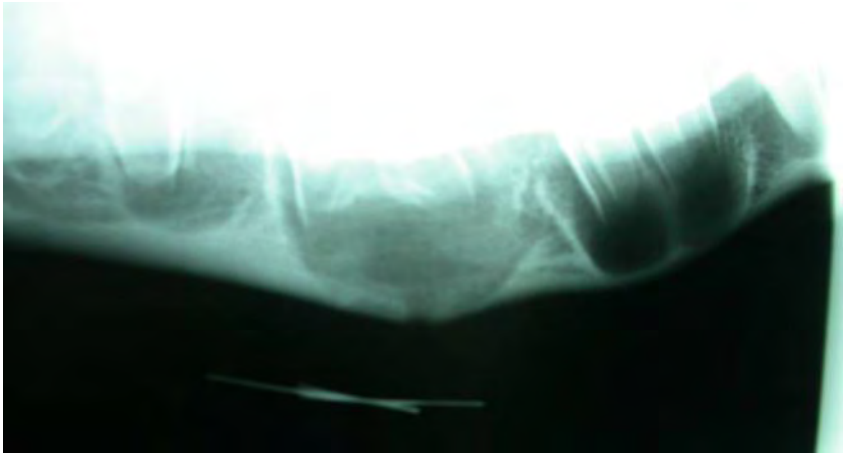

**Figure 3. Radiograph showing a mandibular CT with marked destructive changes due to apical infection and with a sinus tract through the underlying, thin mandibular cortex. A metal maker lies below the area of maximal soft tissue swelling. Note the normal radiolucency of the developing adjacent dental apex (on right).**

A thorough clinical examination including a detailed intra-oral examination should be performed, using an oral speculum and a dental mirror or endoscope (paying particular attention for the presence of discoloured or pitted secondary dentine, or pulpar exposure). Radiographic evaluation of the teeth (especially latero-oblique projections) should always be undertaken, firstly, to absolutely confirm that a tooth needs to be extracted and secondly, to identify *which* tooth is diseased. Scintigraphy can be of great value in some cases.

## Extraction of Cheek Teeth

Extraction of equine CT by any mechanism is a major surgical procedure and many serious immediate and delayed sequelae may occur. Consequently, this procedure should never be undertaken too readily, especially in younger horses. If any doubt remains concerning whether a cheek tooth is infected or not, conservative treatment should be undertaken rather than cheek tooth extraction. Conservative treatments include antibiotic therapy (e.g. a 2-week course of oral trimethoprim and sulphonamide, and metronidazole) for suspect mandibular or rostral (06-09) maxillary apical infections. Maxillary sinus trephination and irrigation, and systemic antibiotic therapy should be employed for suspect caudal maxillary CT apical infections. Failure to respond to the above conservative therapy should prompt a further clinical and radiographic evaluation for dental infection, with serial radiographs sometimes being diagnostically helpful. Only when definitive evidence of cheek teeth infection is present, should dental extraction be considered.

## Oral Extraction of Cheek Teeth

Oral extraction of equine CT was the standard treatment in the 1800s when it was often performed in horses that were cast, without use of any anesthesia or analgesia. The oral

extraction technique was later abandoned for the repulsion technique and much later, when satisfactory equine general anaesthesia was available, the lateral buccotomy technique was used by some surgeons. However, as well as the high expense to owners and the risks of general anaesthesia to horses, the main reason for seeking alternative forms of equine CT extraction was the unacceptably high rate of post-operative problems occurring in horses following repulsion. The current availability of safe and effective sedatives and analgesics has been a major reason for the recent revival of the oral extraction technique in standing horses,[3-7] as much of the oral extraction instrumentation has remained unchanged since the 19th Century. In addition to the lower cost and removal of general anaesthesia risks, oral extraction technique does not usually require surgery of the supporting bones, and most importantly, post-operative complications are less common following oral extraction, and when they do occur, they are usually easier to treat than those occurring following repulsion.

A prerequisite for oral extraction of equine CT is excellent sedation of the horse. This can be achieved by a combination of an alpha-2 agonist sedative and butorphanol (or morphine). Flunixin is additionally administered by some operators. Regardless of the type or level of sedation administered, a small percentage (1-2%) of horses is not temperamentally suitable for standing oral extraction of CT.

Local anaesthesia of the ipsilateral infraorbital nerve can be used to extract a maxillary 06 or 07. The block is performed by inserting a 5-cm long, 21-gauge needle 3-4cm caudally into the infraorbital canal and then slowly injecting 3-5mls of local anaesthetic. With more difficulty, the maxillary branch of the trigeminal nerve, which is sensory to all the maxillary CT, can be anaesthetised as it enters the caudal aspect of the infraorbital canal at the pterygopalatine fossa. Following strict aseptic skin preparation (a retrobulbar abscess would be disastrous), a 9 to 12-cm long spinal needle is inserted caudal to the highest point of the zygomatic arch and is then “walked” ventro-rostro-medially down the orbital aspect of the frontal bone to the rostro-ventral aspect of the orbit, where 20-30 mls of local anaesthetic are deposited. The author does not like this nerve block because of its proximity to the orbit and the risks of introducing infection to this deep site.

The mandibular nerve, which is sensory to all mandibular teeth, can be more readily anaesthetised as it enters the mandibular canal on the dorso-medial aspect of the horizontal ramus of the mandible. The mandibular foramen lies at the intersection of a vertical line at the caudal limit of the orbit with a line parallel to the occlusal surface of the rostral four CT (ignore the occlusal surface direction of the mandibular 10s ands 11s CT in horses with a marked curve of Spee – their occlusal angle can face dorsal to the mandibular foramen). Following skin preparation and subcutaneous local anaesthesia infiltration a 15-cm long, 18-gauge spinal needle is “walked” up the periosteum of the medial aspect of the mandible, and 20-30 mls of lignocaine is deposited at, and 1-3 cm dorso-caudally to the above site, where the near-vertically oriented nerve descends into the canal.

For oral CT extraction, the horse should be restrained in stocks with its head placed on a headstand or suspended in a dental head collar. At least one assistant and preferably two

are needed, to stabilise the head and help with the extraction. A good headlight is also required to absolutely ensure that the correct CT are initially "separated" and that the extraction forceps is placed fully on the appropriate tooth. Prior to extraction, penicillin and an aminoglycoside are administered, and the mouth is rinsed fully of food. In most horses, very little exposed crown is visible on the palatal (medial) aspect of the maxillary CT, with the gingival margin lying just a few mm below the occlusal surface in some horses. In contrast, there is usually adequate clinical crown present on the buccal (lateral) aspects of the maxillary cheek teeth. A metal dental pick can be used to detach the gingiva on the medial aspect of the affected tooth to the level of the alveolar crest. This procedure normally exposes enough dental crown to allow CT extractors to be firmly applied on both the lateral and medial aspects of the maxillary tooth to be extracted. Although there is usually adequate clinical crown exposed on both sides of the mandibular cheek teeth, the gingiva of a mandibular CT is elevated to prevent it from tearing away excessively when the tooth is finally extracted.

A narrow blade CT separator can now be slowly and progressively inserted into the interdental space rostral and caudal to the affected tooth (Fig. 4). It should be kept in place for circa 5 minutes to excessively (i.e. non-physiologically) stretch and so cause damage and haemorrhage of the periodontal ligaments. A series of wider blade CT separators can then be used to further gradually stretch the periodontal ligaments. When extracting an 07 tooth, separators should not be used between the 06 and 07, in case the 06 is excessively pushed forward and loosened. Separators must also be cautiously used when extracting caudal mandibular CT in horses with a marked curve of Spee, where the vertical blades of the separator will not fit into the non-vertical interdental spaces between such CT, but might instead fracture these CT.

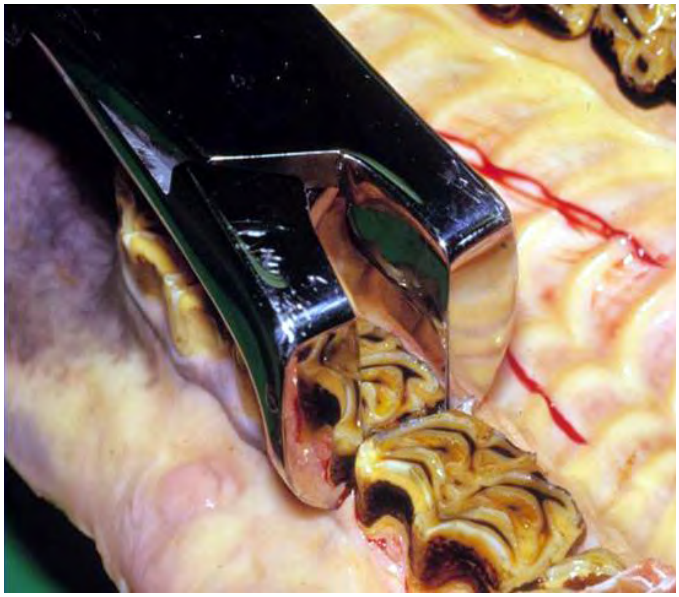

**Figure 4. A pair of cheek teeth ("molar") spreaders is being inserted between maxillary CT in this cadaver skull.**

Following progressive widening of the interdental space, an appropriate CT extractor is then firmly attached to the crown of the diseased tooth and kept in place by an inbuilt mechanism or by an inner tube of a bicycle tyre tightly wrapped around its handles. The CT is then very gently and gradually moved sideways in the horizontal plane. If excessive force is used at this early stage, the clinical crown of the tooth can easily fracture.

**Figure 5. A Routledge type extractor has been applied to an 07 in this cadaver skull.**

**Figure 6. This sedated horse, which is restrained in stocks, has a Routledge-type extractor placed on an infected maxillary CT.**

**Figure 7. Foamy blood is present around this 107 during its oral extraction.**

After a variable period, depending on the extent and health of the periodontal ligament, a "squelching" sound will be heard, and increased movement of the forceps will be appreciated. More force can now be used, increasing movement of the forceps can be appreciated, and foamy blood will appear around the gingival margins of the CT being extracted (Fig. 7). The operator should ensure that the extractor remains tightly fixed to the tooth at all times, because even if slightly loose, the extractor jaws can gradually wear away the peripheral cement (and the vertical ridges of maxillary CT) and then become very loosely attached to the tooth. Further rocking of the extractor will not move the tooth, but will just rapidly wear away, and round off the surface of the tooth and soon may leave little residual tooth to grasp with the extractor, especially with maxillary CT.

When extracting fractured CT, additional care must be taken as the residual tooth remnant may be structurally weak. In such cases, and also when it is difficult to fully grasp a damaged crown, the use of a 3-claw extractor can be invaluable (Fig. 8) but care must be taken not to excessively force the claws into the tooth, in case they further fracture the tooth.

**Figure 8. This apically infected maxillary CT had its clinical crown damaged by a conventional extraction forceps, but was extracted by judicious use of a " 3-claw" extractor.**

After 20-60 minutes (occasionally over 2 hours, depending on the age [i.e. length] of the tooth and the degree of periodontal disease present - hence the advantage of an assistant that can help with the extraction), the tooth will usually become digitally loose, and only at this stage should a fulcrum be placed on the occlusal surface of the tooth rostral to the tooth being extracted. Vertical pressure is now exerted on the forceps, drawing the intact tooth from the alveolus (Figs. 9 and 10). With a caudal mandibular CT, it may be safer not to attempt elevation with a fulcrum, in case this *vertical* force fractures the *obliquely* positioned tooth. Instead, the tooth should be rocked sideways until extremely loose and then extracted in a rostro-dorsal direction digitally. Unlike repulsed CT, the apices of extracted CT are virtually always intact. Chronically infected CT that have very extensive reactive cementum deposition on their reserve crowns, bent CT (Fig. 11), CT with divergent (dilacerated) roots, and CT with pre-existing fractures can be difficult to extract and on occasions, when loose, can be repulsed in the standing horse with a fine punch after drilling a small opening over the apex using radiographic guidance.

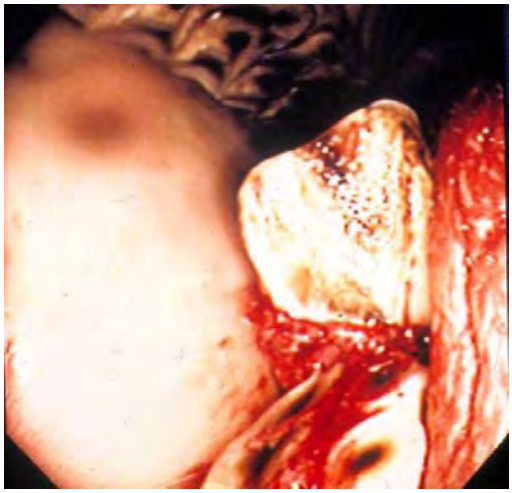

**Figure 9. This loosened mandibular CT has been partly elevated in to the oral cavity**

**Figure 10. Despite limited intra-oral space, oral extraction can be equally successful in small ponies.**

**Figure 11. Orally-extracted young mandibular CT that was somewhat difficult to extract due to medial crown curvature, probably caused by impaction of the tooth before it calcified, and some reactive cement deposition around the infected apex.**

In the absence of a sinus tract or secondary sinusitis, the now empty alveolus can simply be plugged with one or two swabs (containing metronidazole or a dilute povidine iodine solution), to prevent fibrous food from being trapped in a very deep alveolus before it granulates closed. In old horses with shallow (<5cm deep) alveoli, no alveolar packing is required.[4,5] The alveolus should be checked 2 weeks later, when the alveolar packing is removed (if still present). The alveolus should now be palpated, and if healing normally, it should have a smooth outline on all aspects, due to granulation tissue formation. Roughened areas that are palpated are usually caused by sequestration of shell-like areas of alveolar cortex. Smaller sequestra will be spontaneously expelled from the alveolus by granulation tissue formation. Larger residual sequestra (Fig. 12) can be removed digitally or by using right-angled forceps or curettes. Alveoli that still have a deep, large lumen at this stage should have the swab replaced for a further 2 weeks before being re-checked.

If an external sinus tract was present prior to extraction, the bony tract can be gently curetted and the alveolus vigorously lavaged through this site (e.g. using a 500ml oral syringe). In such cases, it is preferable to seal off the oral aspect of the alveolus with dental wax or an acrylic plug and to later gently (to prevent dislodging the overlying alveolar plug) irrigate the sinus tract (e.g. 1-200 mls dilute povidine iodine or saline solution) for a couple of days using a catheter. Such tracts usually spontaneously heal within a week.

When oral extraction of CT is performed on horses with infection of the caudal maxillary CT that also have secondary dental sinusitis, the alveolus can simply be packed with an antibiotic impregnated swab if the apical aspect of the alveolus appears digitally intact following CT extraction (as is usually the case). If the alveolus appears to communicate grossly with the sinus (rare), an acrylic plug should be inserted to prevent the development of an oro-maxillary fistula. In any case, the ipsilateral frontal sinus should be trephined and irrigated with 5 litres of very dilute, lukewarm povidone iodine solution, twice daily for 5-7 seven days.

**Figure 12. This thin alveolar sequestrum was removed from a malodorous, non-healing mandibular alveolus 4 weeks following CT oral extraction. The alveolus fully healed soon after.**

When x-rays have shown that infections of maxillary 08s and 09s are confined to the rostral maxillary sinus (some sinus infections will spread to involve the caudal maxillary sinus) sinus lavage via the frontal sinus is not indicated, as this will usually will not lavage the affected area sufficiently. Trephination of the rostral maxillary sinus should be performed with great care (especially in young horses) to avoid damaging the adjacent CT reserve crown. The trephination site should be radiographically assessed to ensure it is at the site of the extracted CT.

Many cases of apical infection in younger horses can be difficult, both from a diagnostic viewpoint, as well as technically with the oral extraction procedure. Therefore, if a practitioner is in doubt about the diagnosis or treatment of such cases, they should refer these potentially difficult cases to suitably qualified and equipped colleagues. A wide range of equipment is required to successfully remove all sizes and shapes of CT, especially CT of younger horses, and there is an initially steep, and then prolonged learning curve to gain proficiency in this technique in young horses. It is probably most desirable that a small number of equine dental specialists acquire the training and equipment to effectively perform these procedures, and then have enough cases to keep their skill level high. Following successful CT oral extraction by experienced surgeons, postoperative complications are uncommon (occur in circa 10% of cases) and are usually of a minor nature, i.e. are due to non-healing alveoli due to alveolar sequestrate that have not been extruded by granulation tissue, or to localised osteitis. Most of these problems can be resolved without resort to general anaesthesia, by removal of the sequestra, alveolar curettage or antibiotic therapy.

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