

# Periapical Tooth Root Infections in Llamas and Alpacas

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## Background Information

Abscesses around the head and neck are increasingly recognized in South American camelids residing on farms in North America. Although many abscesses are confined to the soft tissues, some originate from the mandibular or maxillary bones. Mandibular and maxillary bone infections may be caused by trauma (e.g. resulting in bone sequestra), infection of a tooth, or hematogenous spread of bacteria (e.g. mandibular osteomyelitis).

Clinical examination of infected teeth suggests that many tooth root abscesses are caused by periodontal disease. In most cases, the crown and pulp cavity are not disrupted. Rather, the periodontal membrane is disrupted by penetration of food particles. Approximately 20% of infected teeth have infection of the pulp cavity most often associated with a patent infundibulum; approximately 60% have evidence of periodontal disease and compromised periodontal ligament; and 20% are of unknown cause. Although tooth root abscesses may be seen in llamas and alpacas of any age, most affected alpacas are aged four to eight years. Also, the most commonly infected teeth are the mandibular molars. Thus, the onset of tooth root abscess occurs during or immediately following the period of eruption of the permanent molars. Clinical studies have associated development of tooth root abscess with the feeding of coarse fiber (stemmy) hays. These observations have led us to form a hypothesis that tooth root abscesses occur as a result of grinding excessively coarse foodstuffs during the period of periodontal exposure while the deciduous teeth are lost and permanent teeth are erupting. Premature loss of deciduous teeth may result in exposure of a susceptible periodontal membrane (Table 1).<sup>3,10</sup> Tooth root abscess involving the canine teeth are unique in that trimming of the crown of the tooth is a routine annual procedure, especially in males, to reduce animal-to-animal trauma.<sup>5</sup> Exposure of the pulp cavity or splitting of the tooth during trimming may result in bacterial infection of the tooth root or dental alveolus.

## Historical Information

The most common complaints by owners are persistent facial swelling, weight loss, poor appetite, purulent drainage, hypersalivation, and loss of pregnancy.<sup>1,2</sup> Swelling may appear to enlarge rapidly (soft

Table 1. Dental anatomy and eruption times.

Tooth	Deciduous (1/3,1/1,2-3/1-2,0/0)	Adult (1/3,1/1,1-2/1-2,3/3)
I1	birth	2 years
I2	birth	3 years
I3	birth	3 to 6 years
C1	+/-, usually -	2 to 7 years
PM3	birth	3.5 to 5 years
PM4	birth	3.5 to 5 years
M1	---	6 to 9 months
M2	---	1.5 to 2 years
M3	---	2.75 to 3.75 years

tissue abscess), be slowly progressive (bone remodeling), or persist unchanged for months. Weight loss, lethargy, anorexia, dropping of feed, and foul odor of the breath also are described.<sup>1,2</sup> Retention of food boluses in the cheek are occasionally observed. Eventually, the bone infection may fistulate either externally as a draining tract (approximately 50% of cases) or internally to the mouth (approximately 40%). Tooth root infections may occur at any age, but most affected animals are four to eight years old.<sup>1,2</sup>

## Physical Examination and Differential Diagnoses

Physical examination is normal except for a focal, hard swelling in the region of the affected tooth. This swelling is usually associated with edema and may have a soft center. A draining tract may be present, or the skin overlying the swelling is intact. These lesions most commonly are seen along the horizontal ramus of the mandible (approximately 80%), and less commonly, the maxilla (15%) or canine or incisor teeth (5%). Differential diagnosis for facial swellings should include tooth root abscess, osteomyelitis (note: to date, *Actinomyces bovis* has not been isolated from a llama or alpaca), soft tissue abscess (including *Corynebacterium pseudotuberculosis*), foreign body, parotid duct lesion, facial bone fracture, retained food bolus, and malocclusion. Chronic tooth abscesses may result in intermittent bacteremia and infection of distant organs. Endocarditis and liver abscesses have been diagnosed in llamas and alpacas with long-established tooth abscesses.

## Radiographic Imaging

Radiographs are indicated for diagnosis of periapical tooth root abscess. Multiple radiographic projections should be done to observe the tooth roots in profile (right and left dorsolateral oblique projection) and to observe the alveolar space and dura (lateral and dorsoventral projection). Intra-oral dental film may provide useful information to better evaluate the affected tooth and mandible. High-quality radiographic images are best obtained while the animal is sedated or anesthetized. Occasionally, an abscess will be found on the medial aspect of the tooth root which is not obvious on standard views. This location of a bone abscess predisposes the mandible to fracture while tooth repulsion is being done. Tooth root debridement or root canal treatment is unlikely to be successful if a bone abscess is present and not treated. Multiple tooth root infections may occur. In one study, 16 of 22 llamas had a single tooth infected, four llamas had two teeth infected, one llama had three teeth infected, and one llama had four teeth infected.<sup>2</sup> Also, radiographs may help to determine the cause of the infection. Tooth root infections may be associated with fracture of the mandible or maxilla, retention of a deciduous tooth root, disruption of the gingiva or a periodontal lesion, fracture of the tooth, or a patent infundibulum. In patients with extensive mandibular osteomyelitis, the specific location of lesions may be obscured. In these cases, computed tomographic (e.g. CT imaging) images of the skull are useful to guiding treatment decisions. Normal anatomy and time of eruption of the various teeth must be considered when interpreting radiographs of the skull (Table 1).

## Recommended Treatment and Surgical Approach

Treatment options for tooth root infections include no treatment, treatment with long-term antibiotics, treatment by curettage, treatment by root canal, extraction of the affected tooth, or removal of a portion of the affected tooth (e.g. sub-crown tooth root resection or tooth splitting). Pregnancy status should be determined in females in which clinical signs are mild. Although surgical treatment may be delayed until after parturition, loss of pregnancy is least likely to occur when surgery is done between the fourth and seventh months of gestation. Antibiotic therapy alone is unlikely to permanently resolve a tooth root infection. However, this may be used as an initial treatment with surgical options reserved for treatment failure.

### *Antibiotic therapy*

Long-term (e.g. four to six weeks) antibiotic administration is expected to have limited success in perma-

nent resolution of tooth abscesses. In one study, eight out of 13 llamas treated with antibiotics, with or without curettage of the diseased bone, had successful resolution of the infection.<sup>1</sup> Necrotic bone should be removed to facilitate resolution of the infection. When antibiotics are used as the sole means of treatment, fewer than 40% of cases are expected to resolve long-term in the author's experience. Extensive curettage of the necrotic bone, in addition to antibiotic therapy, will increase treatment success. Surgical drainage, curettage, and long-term antibiotic therapy is expected to resolve approximately 60% of tooth abscesses. Surgical removal of infected teeth, partially or completely, is expected to be successful in approximately 90% of cases.<sup>1,2</sup>

### *Surgical procedures*

Removal of an infected tooth should be done with the patient under general anesthesia (Table 2).<sup>6-9</sup> Except for canine and incisor teeth, premolar and molar teeth most often have only a single tooth root compromised. The remaining tooth root is securely affixed in bone and considerable effort must be afforded to loosen or remove this root. Incisor and canine teeth may be removed orally using a mucosal flap technique. An osteotome is used to remove the lateral alveolar bone shelf and the root exposed. The infected tooth is removed, the cavity debrided back to normal bone, and the mucosal flap sutured closed. In cases with extensive bone involvement, a drainage port is created ventrally through the skin and a passive drain (e.g. Penrose drain) placed to facilitate drainage. Although the fourth premolar may be accessible orally in some animals, surgical removal of premolars or molars usually requires a lateral approach from the skin or a buccotomy. A lateral approach to the mandible is made by a semi-curved incision with a dorsal base. The skin, subcutaneous tissues, muscle masses, parotid salivary duct, facial artery, vein and nerve, and the periosteum are all reflected en-masse dorsally and the buccal mucosae elevated from the gingiva to expose the crown of the tooth. An osteotome (e.g. a compressed air-driven burr) is used to remove the lateral alveolar plate of the mandible overlying the infected tooth. The tooth is removed and the alveolus debrided. Tooth repulsion by impact, such as that used in horses, is not recommended for use in llamas because the thin mandible is prone to fracture. The author caused fracture of two out of the first 20 tooth extraction surgeries performed using this technique. After changing technique to lateral alveolar plate resection, no mandible fractures have occurred. Maxillary teeth are somewhat more challenging to remove. Intraoperative radiographs are very useful to guide dissection. The maxilla is easier to fracture than the mandible, but these teeth can be equally as difficult to repulse. The parotid duct, externally, and the nasolacrimal duct, internally, should be avoided during dissection and repulsion.

**Table 2.** Drugs used to provide anesthesia or analgesia in camelids.

Use	Drug	Dose	Route
Sedation	Xylazine HCl	0.1 to 0.3 mg/kg	IV, IM, S.C.
	Butorphanol tartrate	0.03 to 0.1 mg/kg	IV, IM, S.C.
General Anesthesia	Medetomidine	10 to 30 ug/kg	IM
	Butorphanol + Xylazine + Ketamine	0.03 mg/kg	IM
		0.3 mg/kg	IM
		3 mg/kg	IM
	Tiletamine/zolazepam	4.7 to 6.0 mg/kg	IM
Halothane	1 to 5 %	OTT or	
Isoflurane	1 to 5 %	NTT	
Reversal Agents	Yohimbine	0.125 mg/kg	IV, IM
	Tolazoline <sup>†</sup>	1 to 2 mg/kg	IV, IM
	Atipamezole	0.125 mg/kg	IV

IV = intravenous; IM = intramuscular; OTT = orotracheal tube; NTT = nasotracheal tube.

<sup>†</sup> Caution: acute death has been observed after rapid IV administration of tolazoline at high dosages.

Adapted from Sarno *et al*, 1996; Waldrige *et al*, 1997.

Reported success rates after tooth removal were 100% (four out of four) and after medical treatment (some with and some without debridement) were 62% (eight out of 13). Of the five llamas having failure of medical treatment, three were subsequently cured by surgical treatment of the affected tooth, two had continued medical or conservative treatment, and one died from juvenile immunodeficiency syndrome. In our experience, medical treatment of tooth root abscesses results in initial improvement that may continue for two to 12 months. However, recurrence of the abscess is common, and surgical treatment at that time is curative.

### Postoperative Management

In most cases, the defect remaining after tooth extraction is left open to drain. The cavity is flushed twice daily until covered with granulation tissue. The author has observed several cases of salivary-loss acidosis following tooth extraction. A cotton wedge may be used to occlude drainage of food and saliva. The author has discontinued the use of intra-oral plugs (e.g. silicone rubber, PMMA, etc) because of complications (prolonged retention of the plug, infection associated with the plug, dysphagia, etc.) associated directly with the dental plug. Wounds heal over a period of 14 to 21 days in most cases. The author has diagnosed three cases of salivary duct cutaneous fistulas. All resolved with surgical revision of the wound. The author has diagnosed several cases of enamel sequestrum and bone sequestrum following tooth extraction. If draining tracts persist beyond 30 days after surgery, radiographs should be obtained to evaluate the healing of the surgical site. Antibiotics are continued for 14 days after surgery. Antibiotic selection

may be changed based on results of microbial culture and sensitivity of bone samples obtained during surgery (Table 3). The most common bacteria cultured from these lesions include *Bacteroides* spp, *Actinomyces* spp, and *Peptostreptococcus* spp.<sup>2</sup>

### Complications of Disease or Treatment

Complications of tooth root infection are not well documented. Continued weight loss, anorexia, difficult mastication, septicemia, endocarditis, osteomyelitis, bone sequestra, damage to adjacent tooth roots or teeth, fracture of the mandible or maxilla, aspiration pneumonia, and bacterial embolization of internal organs have been diagnosed. Dysphagia or malocclusion are rarely seen because llamas and alpacas do not grow their teeth life-long. Over time, molar drift occurs to partially close the gap remaining after tooth extraction. The author has rarely needed to file the opposing tooth as a result of overgrowth into the dental gap.

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**Table 3.** *In vitro* disc diffusion antimicrobial susceptibility results from common pathogens associated with tooth root infection in llamas and alpacas.

Bacteria	Ampicillin	Ceftiofur	Florfenicol	Gentamicin	Penicillin	Tetracycline	Trimethoprim-sulfadimethoxine	Erythromycin
<i>Actinomyces</i> spp	100%	98%	100%	75%	100%	95%	85%	99%
<i>Actinomyces pyogenes</i>	100%	100%	100%	90%	100%	85%	100%	100%
<i>E. coli</i>	50%	80%	40%	98%	0%	73%	74%	0%

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