ELSEVIER
SAUNDERS

Vol 17, No 2
April 2008

# Journal of Exotic Pet Medicine

www.exoticpetmedicine.com

## This Issue:
## Dentistry of Exotic Companion Mammals

Vittorio Capello, DVM
Angela M. Lennox,
DVM, Dip. ABVP (Avian)
Guest Editors

An Official
Journal of
AEMV
Association of
Exotic Mammal
Veterinarians

Journal of
# Exotic Pet Medicine

Vol 17, No 2 • April 2008

## Departments



## Forthcoming Issues

**Reptiles**
*Brad Lock, DVM, Dip. ACZM*

**Amphibians**
*Natalie Mylniczenko, MS, DVM*

## Topics in Medicine and Surgery: Dentistry of Exotic Companion Mammals

Journal of
# Exotic Pet Medicine

# Clinical Technique: Treatment of Periapical Infections in Pet Rabbits and Rodents

*Vittorio Capello, DVM*

*Abstract*

**Periapical infections, abscesses, and osteomyelitis are common sequela in pet rabbits and rodents after congenital or acquired dental disease. Aggressive treatment is usually required, utilizing different surgical options. Gaining complete surgical access to the infection site, thorough debridement, marsupialization of soft tissues, and postoperative local treatment are required to manage these cases because of animal's size and natural anatomical features. In this article, different surgical options for periapical infections will be described. Copyright 2008 Elsevier Inc. All rights reserved.**

*Key words:* **rabbit; rodent; periapical infection; abscess; osteomyelitis; surgery**

Periapical infection and subsequent abscessation of soft tissues and osteomyelitis of the surrounding mandibular or maxillary bones are a common sequela in rabbits and rodent species after congenital or acquired dental disease (Fig 1). This complication must be considered during diagnosis and prognosis, because in early stages, initial focus of infection can be very subtle and completely subclinical.

## Pathophysiologic and Clinical Considerations Related to Periapical Infections in Pet Rabbits and Selected Species of Rodents

Rabbits and porcupine-like rodents (e.g., guinea pigs, chinchillas, degus) are herbivorous species with elodont teeth. Incisor teeth are also elodont in rat-like rodent species (e.g., rats, hamsters, gerbils, mice) and squirrel-like rodents (e.g., prairie dogs, other squirrels). Because these continuously growing teeth do not develop a true anatomical root, the subgingival structures are referred to as the "reserve crown" and the "apex."

Periapical infections are common in pet rabbits and represent an important part of the disease process. Because of the peculiar anatomy of the teeth and the relationship between the reserve crown and the maxillary and mandibular alveolar bones, periapical infections spread to surrounding bone and soft tissues, producing osteomyelitis and abscess (Fig 2).[1]

Much of the pathophysiology and clinical implications of periapical infections and abscessation in rabbits, when compared with the same disease in nonherbivorous species, are not yet completely understood. For example, why they do not seem to be painful until at an advanced stage; why they do not elicit hyperthermia even if they are a true bacterial infection; why they tend to be encapsulated and progressively destroy the surrounding bone.

Rabbits are a prey species and are naturally prone to hide the clinical signs of a disease. Therefore, it is

*From the Clinica Veterinaria S. Siro, Milan, Italy.*

*Address correspondence to: Vittorio Capello, DVM, Clinica Veterinaria S. Siro, via Lampugnano 99, 20151 Milan, Italy. E-mail: capellov@tin.it.*



*1557-5063/08/xx0x-$30.00*

*doi:10.1053/j.jepm.2008.03.009*

**Figure 1.** Typical facial mass after periapical infection of a mandibular cheek tooth. These can be ulcerated or covered with an eschar. Reprinted from: Capello V, Gracis M, Lennox A (eds): Rabbit and Rodent Dentistry Handbook. Zoological Education Network (2005), Blackwell Publishing (2007) with permission.

easily understood why the clinician frequently faces advanced stages of acquired dental disease already complicated by periapical infection, abscessation of soft tissues, and osteomyelitis. Anatomical features and small size of the skull and teeth of rabbits contribute to make treatment difficult to extremely challenging.

## Medical Treatment Versus Surgical Treatment: The Role of Osteomyelitis

Because osteomyelitis is often associated with bacterial infections, antibiotic therapy would appear to represent a treatment of choice. The ideal therapeutic choices should be based on results of culture and antibiotic sensitivity, keeping in mind that the core of the abscess is usually sterile, anaerobic organisms are frequently involved, and there is the potential for toxicity with many common antibiotics in rabbits. Nevertheless, with the exception of some anecdotal reports, no clinical trials have demonstrated that medical therapy alone is effective for treating this disease condition in rabbits. Actually, this is very easy to understand if the 3 peculiar traits of periapical infections and abscesses of rabbits are considered: the presence of a capsule, the presence of necrotic tissue—soft, dental, or bony—and the presence of the osteomyelitis.

It is important to address these 3 pathologic conditions to obtain a long-term therapeutic success and prevent reoccurrence. Success, therefore, hinges on extensive, aggressive surgical treatment.[1-5] Medical treatment also includes supportive (e.g., fluids, force feeding) and analgesic therapy. However, in the author's experience, both are seldom required in pet rabbits, with the exception of the presence of gastrointestinal disease such as gastrointestinal stasis. Rabbits usually return to a normal appetite soon after dental or extraoral surgical treatment, and show an evident relief even after aggressive surgery therapy.

## Treatment Options

A number of surgical techniques and options have been proposed beyond the simple and usually ineffective incision of the abscess and flushing of the purulent material. Opening the capsule, excising the entire abscess capsule with either primary closure or marsupialization,[1,2,4] and packing the surgical site with polymethylmethacrylate beads,[6,7] calcium hydroxide, honey or sugar solution,[5] or bioactive ceramics[3] have been reported. Options for treatment of periapical infections reported in the literature are listed in Table 1.

Assuming that medical treatment alone is ineffective or palliative, the surgical treatment of choice, in this author's opinion and experience, is that which addresses the three typical pathologic conditions related to periapical infections. In addition to excision of the capsule and debridement of the bone, any fragments of diseased teeth must be carefully located and removed (Fig 3). Intraoral extraction of the tooth is often not enough, because the diseased tooth is frequently fractured, or may fracture during extraction because it is partially reabsorbed or ankylosed to small pieces of necrotic bone.[1,2]

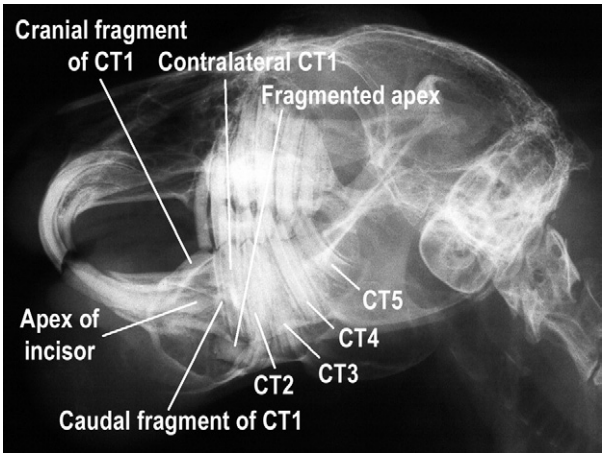


**Figure 2.** Radiograph (left 15° dorsal to right ventral oblique projection) demonstrating periapical infection after longitudinal fracture of right mandibular cheek tooth 1, and involvement of the apex of the right mandibular incisor tooth. Note the L-shaped deformed apex of cheek tooth 2.

**Table 1. Treatment options reported in literature**

| Treatment | Drug/Technique | Adjunct Technique | Author's Experience |
|---|---|---|---|
| Medical | Long-term injectable penicillin | | Ineffective or palliative |
| Surgical | Incision of the capsule | Curettage and flushing of the purulent material | Ineffective |
| Surgical | Incision of the capsule | Curettage/flushing/packing of the abscess | Ineffective or effective for a short time |
| Surgical | Excision of the entire abscess (including the capsule); extraction of the diseased teeth; debridement of the infected/necrotic bone | Primary closure of the wound | Ineffective or frequent relapse |
| Surgical | Same as above | Introduction of long-term antibiotic drugs (Doxirobe gel; Pfizer Animal Health, New York, NY USA) | |
| Surgical | Same as above | Introduction of antibiotic-impregnated PMMA beads; closure of the wounds | Frequent relapse |
| Surgical | Same as above | Introduction of honey or sugar solutions | |
| Surgical | Same as above | Introduction of calcium hydroxide | |
| Surgical | Same as above | Introduction of bioactive ceramics | |
| Surgical | Same as above | Marsupialization of the site to facilitate postoperative flushing and debridement, application of healing-promoting products, healing by secondary intention | Very effective |
| Surgical and medical combined | Same as above; injectable penicillin (or other antibiotic deemed appropriate) | Marsupialization, and so forth (see above) | Best option |

Ideally, the surgical technique should allow frequent postoperative debridement of the surgical site and flushing and application of antiseptics or other products to promote healing, and allow constant direct monitoring of healing until it occurs by second intention.[1]

In reality, these techniques are based on the same basic principles of orthopedic repair in the presence of a grade III open fracture and an osteomyelitis. The fracture repair is usually performed with an external fixation technique, and the infected site left partially exposed. Marsupialization of the surgical site allows these same surgical principles to be applied in cases of osteomyelitis of the skull.

## Surgical Treatment: The First Key for a Successful Outcome

Removal of the entire capsule is accomplished by incising the skin over the abscess and then carefully dissecting the intact capsule from the surrounding tissues, taking care not to enter the abscess cavity. Once the capsule has been isolated up to the point where the abscess connects with bone, the capsule is incised and removed along with the purulent material (Fig 4). A specimen for culture and antibiotic sensitivity can be collected from the capsule wall at this point. When very thin, the capsule can be accidentally incised during dissection, but it is always important to remove it completely. The proliferative, pathologic cortical bone at the junction with the capsule is gently removed with rongeurs. In cases of extensive osteomyelitis where use of rongeurs may pose a risk of fracture, diseased cortical bone can be carefully burred with high-speed dentistry equipment. Next, the osteomyelitic bone cavity is cleaned of any remaining debris or material and debrided to the point of bleeding with a bone curette or rongeurs (Fig 5). Once the cavity is fully exposed, the affected tooth/teeth, or their fragments, and/or additional necrotic bone will be visible inside the osteomyelitic cavity. These are gently removed with

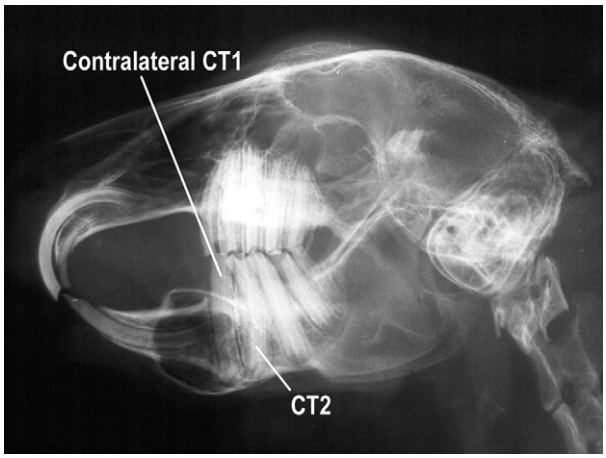


**Figure 3.** Postoperative radiograph demonstrating extraction of the affected incisor, fragmented cheek tooth 1, and fragmented apex. Note that in a true lateral projection, cheek tooth 2 appears abnormally curved, but the L-shaped apex is more difficult to detect.

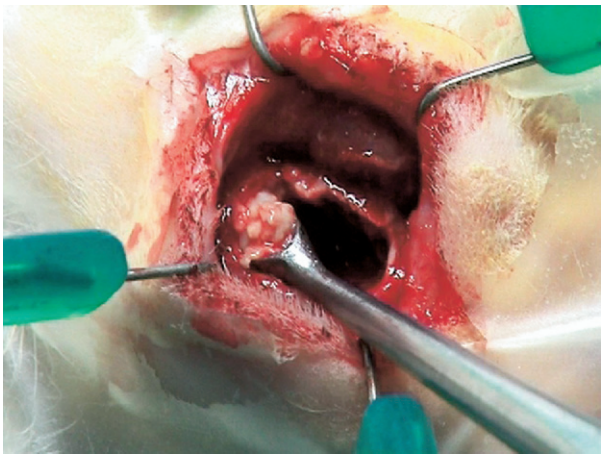

**Figure 5.** Debridement of the bone cavity with a Williger bone curette. Reprinted from: Capello V: Extraction of cheek teeth and surgical treatment of periodontal abscessation in pet rabbits with acquired dental disease. Zoological Education Network (2004), with permission.

contoured needles or dental elevators, and the site is thoroughly flushed with saline solution (Fig 6).

## Postoperative Treatment and Care: The Second Key for a Successful Outcome

Marsupialization of the surgical site is performed by suturing the skin, the subcutaneous tissue, and the fascia with 3–0 or smaller nonabsorbable suture material in a simple interrupted pattern (Fig 7). This technique produces a temporary, less appealing cosmetic outcome, but allows daily debridement, flushing, and packing with antibiotic ointments (Fig 8). All these procedures can be performed with careful manual restraint of the patient and without the use of anesthesia. Owners must be prepared for a temporary unattractive cosmetic appearance, but most can be taught to assume part of the postoperative care at home. Frequent veterinary rechecks for debridement and evaluation of progress are recommended and should be discussed with the owner before surgery.

A few days after surgery, when the osteomyelitic bone site has been cleaned of remaining debris, the topical antibiotic ointment is replaced with healing-promoting ointment. When a granulation tissue layer begins to cover the bone cavity, the marsupialization sutures are removed (around 10 to 12 days postsurgery). Both the osteomyelitic bone defect and wound are allowed to granulate by second intention. Total healing time is often 2 to 4 weeks (Fig 9).

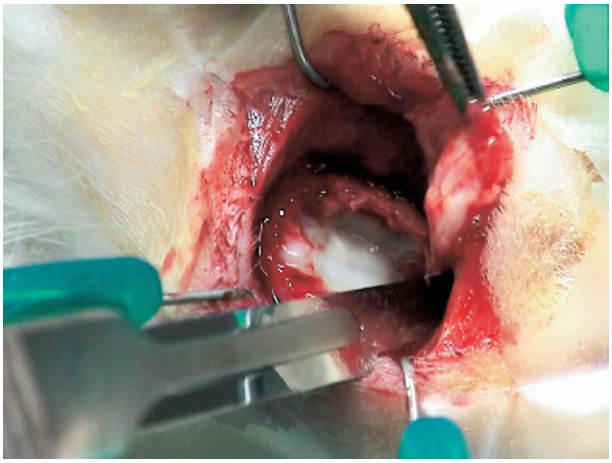

**Figure 4.** Complete removal of the capsule of a periapical abscess at the point where the abscess connects with the bone.

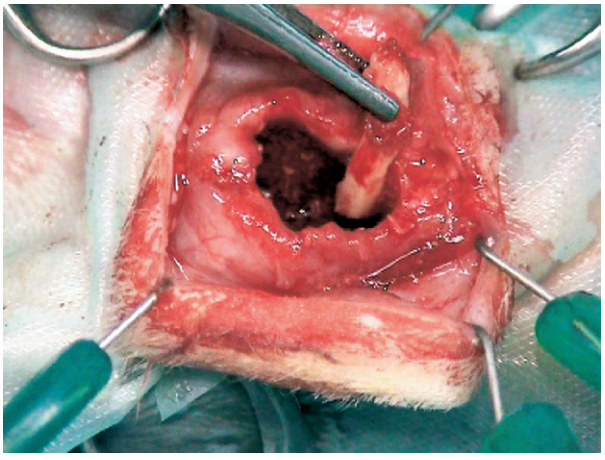

**Figure 6.** Extraction of a diseased tooth from the osteomyelitic site.

**Figure 7.** Postoperative appearance of the marsupialized surgical site. Owners must be prepared for the temporary disfiguring cosmetic appearance.

Marsupialization with delayed healing by secondary intention is also critical in cases of simultaneous extraction of 1 or 2 cheek teeth, where suturing of the gingiva is not possible. In these cases, impaction of the alveolus with food can occur. Even if food debris passes through the oral/extraoral fistula and through the bone, marsupialization allows flushing and of the fistula until the apposition of new bone and healing of the gingiva effectively close the fistula. A certain delay of the healing process is expected when an oral fistula is present; frequent flushing with saline solution is therefore critical to keep the surgical site clean. Despite exposure of part of the deep bone, marsupialization is well tolerated by rabbits, and most do not require an Elizabethan collar or force feeding.

**Figure 8.** Debridement of the bone cavity and the soft tissues helps promote bleeding of healthy tissues and healing by secondary intention.

**Figure 9.** Follow-up, 4 weeks postsurgery.

Although this procedure requires a longer and more difficult postoperative period and significant owner commitment and aftercare, it is associated with a higher percentage of successful outcomes. In this author's experience, it is the only therapeutic option providing long-term positive outcomes in cases of severe and/or extensive periapical infections and osteomyelitis.

## Diagnosis and Prognosis

Accurate diagnosis is the key to determination of prognosis and planning of successful management. The clinician must keep in mind that the severity of the bone infection is not directly related to the severity of clinical signs. Therefore, complete presurgical evaluation is necessary to determine the extent of infection and to help identify those patients unlikely to respond to therapy.

Excellent quality radiographs of the skull and teeth require high-resolution radiographic film such as mammography film. Views are made in 5 basic projections: lateral, 15° right oblique, 15° left oblique, ventrodorsal, and rostrocaudal. Computed tomography (CT) is becoming increasingly available and affordable and is extremely beneficial for small exotic mammal patients. In most cases, a CT scan is superior to plain radiography in terms of diagnosis and prognosis. In particular, 3-dimensional surface reconstruction of the skull can determine the exact extent of osteomyelitis, and rule out patients for whom surgery is not an option or for those in which the surgical procedure will be very challenging. Another advantage of CT is the capability to detect the presence of abscess fistulas that open medially, for example abscesses involving the tongue or associated soft tissues.

## Challenging Cases

The surgical technique and the postoperative management described above represent treatment options for the more common, less severe periapical infection of incisor teeth, and of more rostral mandibular or maxillary cheek teeth (1-3). However, this technique is not appropriate in all cases (e.g., extensive osteomyelitis of larger portions of skull).

Because of the anatomical features of the rabbit skull, cases that are more difficult often include periapical abscesses of the caudal cheek teeth. Periapical infections and osteomyelitis of the second and third mandibular molar teeth (mandibular cheek tooth 4 and cheek tooth 5) are uncommon, but carry a poorer prognosis because the caudal portion of the body of the mandible is much thinner when compared with the main part of the body of mandible containing mandibular cheek teeth 1-3. Deep and complete debridement of the osteomyelitic bone is not always feasible, and the risk of intraoperative complications (e.g., fracture of the mandible during the debridement of the osteomyelitic bone) is much higher (Fig 10). It should be noted, however, that fracture of the mandible during debridement of this area is not always associated with poor outcome; powerful masseteric muscle can provide enough stabilization to allow the fracture to heal during the postsurgical period. The cranial portion of the masseteric muscle also makes surgical access much more difficult. Precise diagnosis is important to choose the surgical candidate with a reasonable prognosis and to plan surgical access.

**Figure 10.** Periapical infection and resultant osteomyelitis after fracture of right maxillary cheek tooth 4 in a large rabbit. The radiolucent area is a bone cavity with irregular, thickened margins within the alveolar bulla. The bone cavity contained purulent material. Reprinted from: Capello V, Lennox A: Clinical Radiology of Exotic Companion Mammals. Wiley-Blackwell Publishing (2008), with permission.

**Figure 11.** Radiologic appearance of the bone cavity after it has been filled with PMMA beads through lateral maxillotomy access. Reprinted from: Capello V, Lennox A: Clinical Radiology of Exotic Companion Mammals. Wiley-Blackwell Publishing (2008), with permission.

Retrobulbar abscesses in pet rabbits are a common sequela of dental disease due to the anatomical relationship between the apexes of the maxillary cheek teeth and the orbital fossa. In rabbits, a peculiar bone structure called the alveolar bulla includes the reserve crown and apexes of the 4 caudal cheek teeth (the third premolar and the 3 molar teeth).[1,2,8] When a periapical infection involves one or more of these cheek teeth, the alveolar bulla acts as a preformed bone cavity and can fill with food debris, tooth fragments, and pus. If the thin dorsal cortical bone of alveolar bulla is perforated, a true retrobulbar abscess occurs. Retrobulbar abscesses are commonly diagnosed when they produce increased pressure behind the globe and/or panophthalmitis. Advanced cases presenting late in the course of the disease result in loss of the orbit and necessitate enucleation. This procedure allows dorsal surgical access to the alveolar bulla, but also risks exposure of the optic nerve and the optic foramen and is also not ideal for aesthetic reasons.

Diagnosis of abscessation of the alveolar bulla is ideally made before development of a retrobulbar abscess, and therefore before the eye is compromised and possible lost. An extraoral (lateral) approach as for abscesses of the mandibular cheek teeth is extremely difficult because of the presence of the zygomatic arch, and therefore the marsupialization technique cannot be applied in this case. An intraoral approach to the alveolar bulla through the tooth socket after extraction of the diseased maxillary cheek tooth/teeth is feasible and has been reported.[2,9]

Access to the bulla is difficult, because the fistula is much smaller than the bulla itself, which does not facilitate proper debridement. The only option is to frequently flush pus and food from the bone cavity, which requires frequent anesthetic procedures and does not help promote filling of the newly formed cavity.

A lateral extraoral surgical approach to the alveolar bulla by partial excision of the zygomatic arch has been reported by the author in a 5-year-old male Flemish giant rabbit.[2] After the ventral margins of the zygomatic arch were surgically exposed, the cranial portion of the proximal end of the masseteric muscle was dissected. A small portion of the zygomatic arch was burred away to approach the lateral side of the alveolar bulla. The resulting lateral fenestration was large enough to introduce a small Volkmann's spoon to debride the inner cavity, flush it, and to introduce small antibiotic-impregnated PMMA beads (Fig 11). Once the alveolar bulla was filled, the muscular fascia of the masseteric muscle was sutured with the zygomatic portion of the zygomatic muscle. The subcutaneous tissue and the skin were then routinely sutured.

To prevent the loss of the antibiotic-impregnated PMMA beads through the oral fistula into the oral cavity and penetration of food and debris from the oral cavity into the surgical site, a resin glass ionomer (Geristore; Den-Mat Corporation, Santa Maria, CA USA) was applied intraorally to seal the fistula of the alveolar bulla.

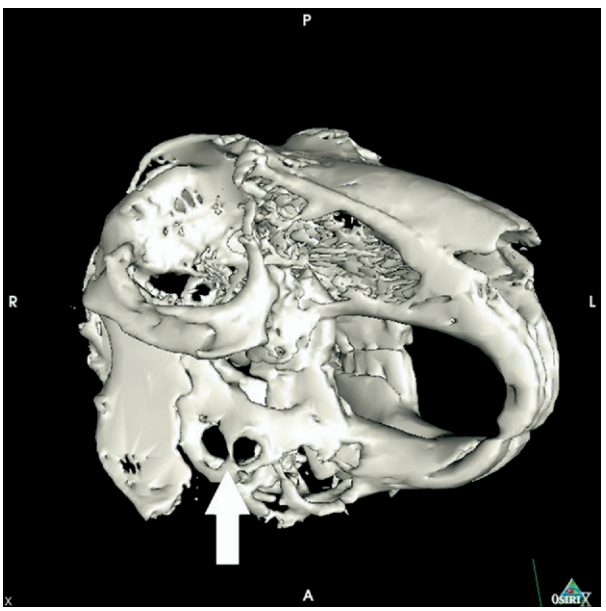


**Figure 12.** Three-dimensional surface reconstruction CT scan (shaded surface display) showing a vertical fracture between the branch and the body of the mandible. This complication is common during surgical access of osteomyelitis of cheek tooth 4 and cheek tooth 5 (*arrow*). Note that the osteomyelitic site also extends cranially (Courtesy of Angela Lennox, DVM). Reprinted from: Capello V, Lennox A: Clinical Radiology of Exotic Companion Mammals. Wiley-Blackwell Publishing (2008), with permission.

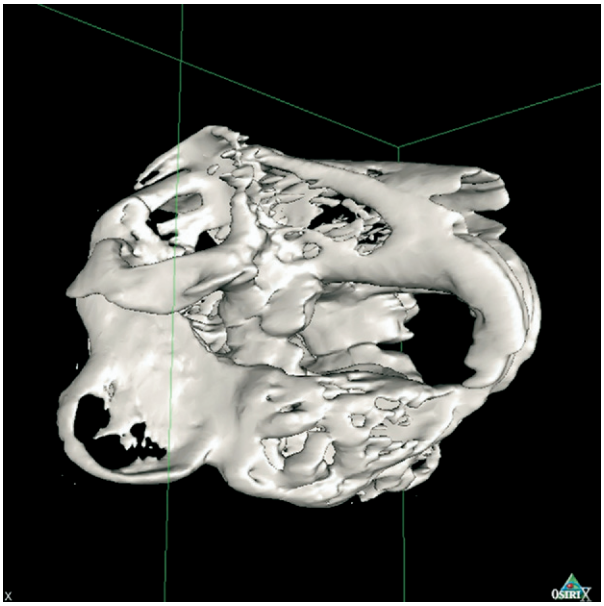

**Figure 13.** Shaded surface CT display demonstrating severe osteomyelitis. The affected bone is more rostral than that in the rabbit shown in Figure 12. This patient underwent successful rostral hemimandibulectomy. Reprinted from: Capello V, Lennox A: Clinical Radiology of Exotic Companion Mammals. Wiley-Blackwell Publishing (2008), with permission.

Severe, diffuse, and/or bilateral cases of osteomyelitis of the mandible can be extremely challenging as well (Fig 12). Bone healing by secondary intention may be impossible when the body of the mandible is completely affected. Successful rostral hemimandibulectomy has been reported in a case of mandibular neoplasia, but this end-stage surgical option can also be considered for cases of diffuse osteomyelitis (Fig 13). The author has had a successful case of rostral hemimandibulectomy in a 1.3-kg 2-year-old intact male dwarf rabbit.

An incision of the skin and blunt dissection of the soft tissues were performed over the lateral aspect of the mandible to expose the bone, after local block of the mental nerve. The soft tissues were dissected free from the ventral margin of the mandible and the mandibular symphysis separated with the use of a scalpel blade. A buccotomy was then performed by dissecting the gingiva from the underlying bone. The body of the mandible was incised caudal to the osteomyelitic site with a rotating burr. The digastric muscle was dissected free from the medial side of the mandible, taking care to prevent damage to the

sublingual artery. The incisive portion of the mandible and part of the body of the mandible affected by osteomyelitic were finally removed. Suturing the soft tissues of the medial side closed the oral cavity, while suturing the fascia and skin closed the lateral side.

## Periapical Infections and Osteomyelitis in Rodents

Despite similar anatomy and physiology of teeth, guinea pigs and chinchillas seem to be much less prone to periapical infections and osteomyelitis than rabbits. It is still unclear why, despite frequent perforation of the cortical bone by deformed apexes in chinchillas. The general surgical guidelines (excision of the capsule, debridement, extraction of the tooth involved, flushing, and marsupialization) are the same as described for the rabbit. Unlike rabbits, however, the cheek teeth always lie beneath the masseteric muscle, making both surgical access and marsupialization more difficult. The same anatomical consideration is true for smaller species of the ratlike groups. Hamsters and rats are sometimes presented for extremely large abscessations involving the masseteric muscle after fractures of the anelodont (truly rooted) cheek teeth. Periapical infections associated with malocclusion and fractures of incisor teeth are also relatively frequent. Unfortunately, early diagnosis is more difficult in these species because clinical signs are rarely shown before severe involvement of the bone and adjacent tissues occur. Surgical prognosis is usually guarded to poor for periapical infections and osteomyelitis in rodents because of size and extensive involvement.

## References


1. Capello V, Gracis M: Surgical treatment of periapical abscessations, in Capello V, Gracis M, Lennox A (ed): Rabbit and Rodent Dentistry Handbook. Lake Worth, FL, Zoological Education Network, 2005, pp 249-273
2. Capello V: Management of difficult periapical infection in rabbits. Proc Assoc Exotic Mammal Vet Conf 91-97, 2007
3. Aiken SA: Small mammal dentistry (part III), in Quesenberry KE, Carpenter JW (eds): Ferrets, Rabbits and Rodents: Clinical Medicine and Surgery (ed 2). St Louis, MO, Saunders/Elsevier, 2004, pp 379-382
4. Hernandez-Divers SJ: Molar diseases and abscesses in rabbits. Exotic DVM 3:65-69, 2001
5. Harcourt-Brown FM: Treatment of facial abscesses in rabbits. Exotic DVM 1:83-88, 1999
6. Divers SJ: Mandibular abscess treatment using antibiotic-impregnated beads. Exotic DVM; 2(5):15-18, 2000
7. Bennet RA: Management of abscesses of the head in rabbits. Proc North Am Vet Conf 822-823, 1999
8. Popesko P, Rjtovà V, Horàk J. A Colour Atlas of Anatomy of Small Laboratory Animals Vol. 1: Rabbit, Guinea Pig. London, Wolfe Publishing Ltd. 1992
9. Martinez-Jimenez D, Hernandez-Divers SJ, Dietrich U, et al: Endosurgical treatment of a retrobulbar abscess in a rabbit. J Am Vet Med Assoc 230:869-872, 2007