Article #2

Dentistry in Pet Rabbits

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ABSTRACT:

Incisor malocclusion is common in rabbits. If this condition occurs as an isolated entity at an early age, it probably has a genetic origin. Incisor malocclusion in older animals is usually secondary to, or occurs concomitantly with, premolar–molar malocclusion. Therefore, patients with incisor malocclusion should always receive a comprehensive oral examination. Incisor–premolar–molar malocclusion with periodontal and endodontic disease is a disease complex that may include incisor malocclusion, distortion of the premolar–molar occlusal plane, sharp points or spikes, periodontal disease, periapical changes, apical elongation, oral soft tissue lesions, and maxillofacial abscess formation. It is unclear whether this syndrome has a genetic, dietary, or metabolic origin. Therapeutic options for incisor–premolar–molar malocclusion with periodontal and endodontic disease may include occlusal adjustment of involved teeth, extraction of teeth severely affected by endodontic and/or periodontal disease, and abscess debridement. Because rabbits with dental disease often have concurrent disease processes, a thorough systemic evaluation is usually indicated before initiating dental treatment. Balanced anesthetic technique with careful monitoring, attention to supportive care, and client education are important in successfully treating rabbits with dental disease.

Rabbits have a diphyodont dentition (i.e., characterized by successive development of deciduous and permanent sets of teeth), although the deciduous first incisors are generally shed around birth and go unnoticed.[1–4] The deciduous second incisors and premolars are present at birth and exfoliate within a month after birth.[2,4,5]

The dental formula for the permanent dentition in rabbits is as follows (Figure 1):

$$I\,2/1:C\,0/0:P\,3/2:M\,3/3 = 28$$

All permanent teeth in rabbits are elodont (i.e., continuously growing, "open-rooted")[6] (Figure 2). Some authors use the term *aradicular hypsodont*, indicating that the teeth have a long anatomic crown, erupt continuously, and remain open-rooted.[1,7] The presence of maxillary second incisors, also known as *peg teeth*, behind the first incisors is typical in lagomorphs.[1,8]

The first incisors are very long and curved in rabbits. The maxillary first incisors and mandibular incisors grow at rates of 2 and 2.4 mm/wk, respectively.[9] The enamel of the incisors is not distributed uniformly around the tooth; the enamel is thicker on the facial aspect and thinner on the lingual aspect.[8] There are no canine teeth. Rabbits have a typical herbivore occlusion: The premolars and molars are grouped as a functional unit with a relatively horizontal occlusal surface with transverse enamel folds (i.e., lophodont teeth) for shredding and grinding tough fibrous food.[10] The enamel folds correspond to deep invagination of

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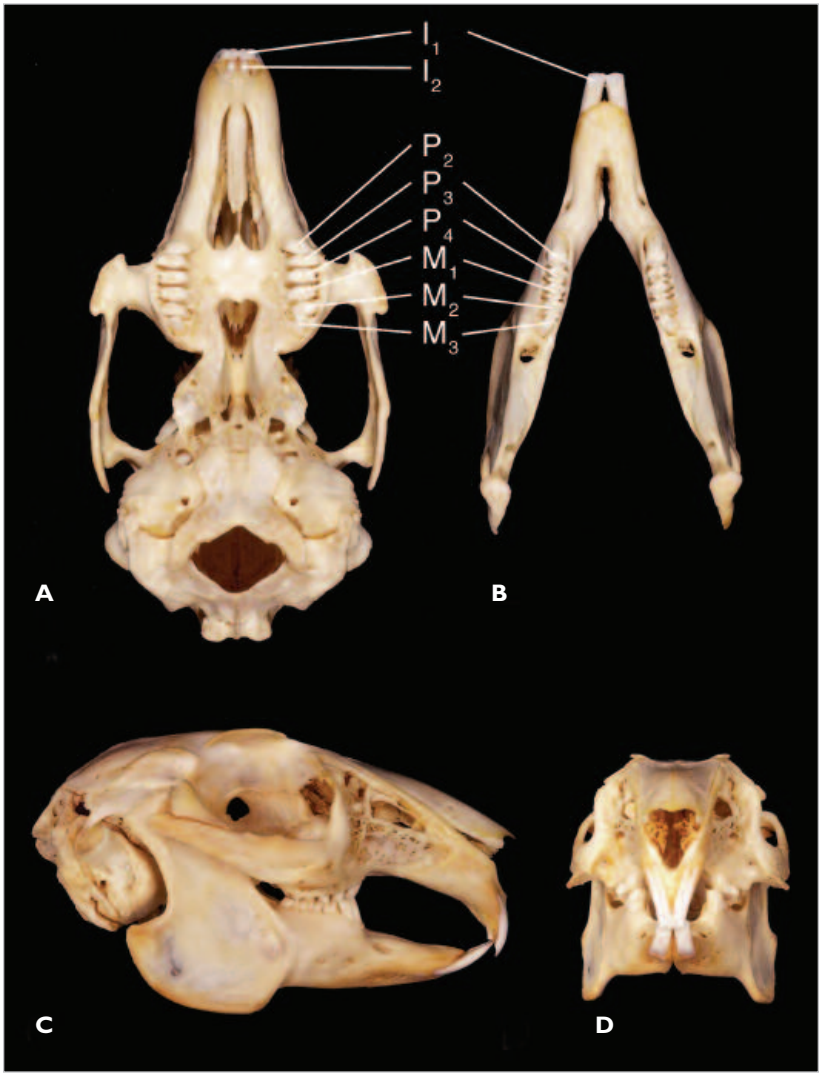

Figure 1. Dentition of the rabbit *(Oryctolagus cuniculus)*:
A: Occlusal view of the maxillae.
B: Occlusal view of the mandibles.
C: Lateral view.
D: Frontal view illustrating the angle of the occlusal plane between the premolars and molars.
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the enamel on the palatal side of the maxillary cheek teeth and the buccal side of the mandibular cheek teeth.[5,8,10] Enamel folds are filled with cementum-like material and are visible on the outside as developmental grooves.[5,8] The peripheral enamel is thickest on the lingual surfaces of the maxillary cheek teeth and the buccal surfaces of the mandibular cheek teeth.[8]

The masseter muscle is much larger than the temporal muscle, and the coronoid process is small compared with that of carnivores (as an adaptation of eating tough, fibrous foods).[11] The occlusion is anisognathous—the maxillary arch is wider than the mandibular arch. The occlusal plane is angled approximately 10° toward horizontal[1] (Figure 1). The shape of the temporomandibular joint mainly allows considerable lateral movement but very little rostrocaudal movement.[1,12] The mandibular incisors occlude between the maxillary first and second incisors.[13]

DENTAL DISEASE SYNDROMES

Clinical Signs of Dental Problems

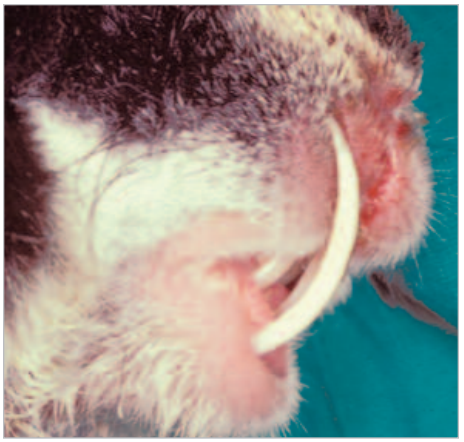
Many signs of dental disease in rabbits are nonspecific.[14–17] Animals with painful teeth, jaws, or oral mucosa may be reluctant to eat or may not be able to prehend, chew, or swallow food well. Although food bowls must be refilled, clients may notice that their animal is steadily losing weight because food is often scattered rather than eaten. Fecal pellets often become smaller because a rabbit is eating less, or, if a rabbit is completely anorectic, fecal output may cease completely. Body fur may appear unkempt if a painful animal no longer uses its mouth for grooming; animals may grind their teeth frequently because of discomfort. Maxillofacial abnormalities may be palpable or evident on inspection. Excessive salivation (i.e., "slobbers") is common. Palpable facial or mandibular swellings may be due to periapical pathosis or soft tissue infection and abscessation. Ocular and/or nasal discharge is suggestive of dental disease. Discomfort while the clinician manipulates the jaw and inability to completely close the mouth may be present. Incisor overgrowth and/or malocclusion are often evident during preliminary visual inspection. Despite the fact that dental disease in rabbits is usually chronic, these patients can present as emergencies due to acute decompensation.

Incisor Malocclusion

Incisor malocclusion is common in pet rabbits (Figure 3). If this condition occurs as an isolated entity at an early age, it is probably due to maxillary brachygnathia, which

has a genetic origin.[13,18,19] Some authors use the term *mandibular prognathism*, which implies that the mandible is too long.[13,16] However, in most cases, especially in small rabbit breeds, the maxilla is too short, whereas the mandible is a normal length; therefore, the term *maxillary brachygnathia* is preferred.[1,18] Because of abnormal incisor occlusion, insufficient attrition occurs, resulting in excessive overgrowth of the incisors.[13] The maxillary incisors, with their inherently greater curvature, typically curl into the oral cavity, whereas the mandibular incisors grow in a dorsofacial direction. If left untreated, trauma to the lip, palate, and other maxillofacial structures may occur.

Figure 3. A rabbit with severe incisor malocclusion. Note the soft tissue trauma to the upper lips caused by the mandibular incisors.



Lateral view.

Frontal view.

A total lack of dietary material for gnawing may also result in incisor overgrowth. Incisor overgrowth may occur subsequent to the loss or fracture of an opposing incisor. This may be caused by the animal falling or being dropped.[16] Fracture of an incisor tooth may result in pulpal necrosis, periapical disease, and cessation of growth and eruption.

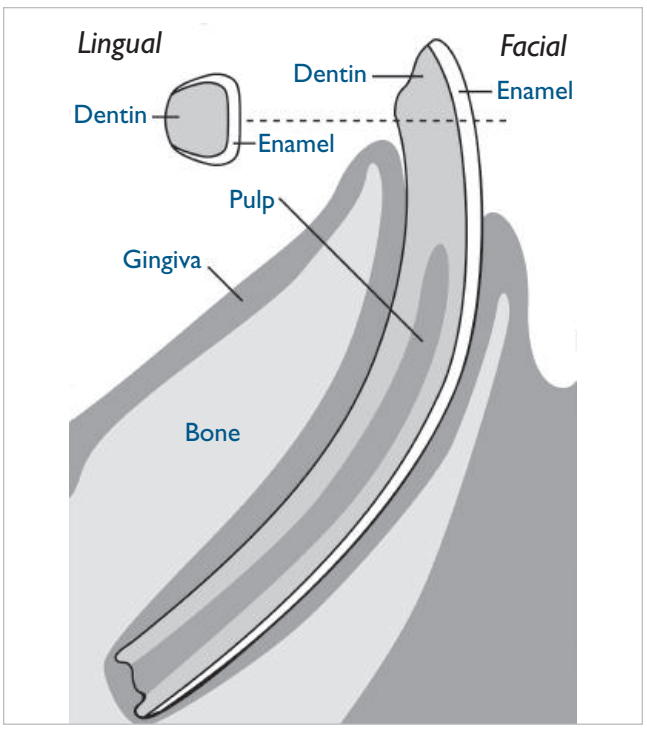


Figure 2. Basic structure of the rabbit incisor. (Illustration by Felecia Paras)

Incisor malocclusion may also be secondary to, or occur concomitantly with, premolar–molar malocclusion. Conversely, incisor malocclusion may lead to premolar–molar malocclusion if incisor malocclusion prevents normal mastication. In fact, incisor malocclusion without premolar–molar abnormalities may be relatively rare, especially in older rabbits.[16] Therefore, patients with incisor malocclusion should always be given a comprehensive oral examination.

Therapeutic options for incisor malocclusion include:

- Tooth height reduction every 3 to 6 weeks, or as needed, and appropriate dietary adjustment
- Extraction of involved teeth

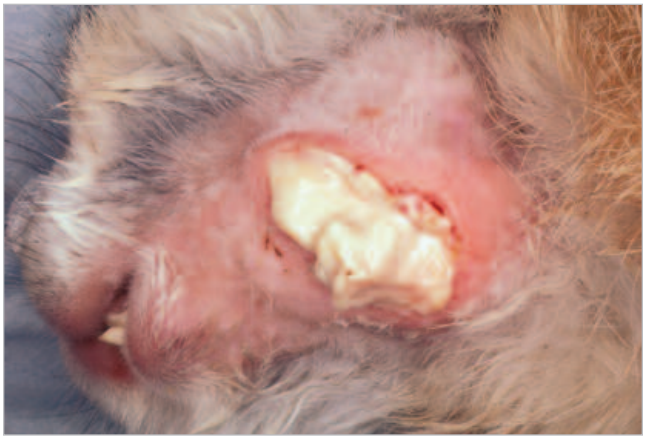
Incisor–Premolar–Molar Malocclusion with Periodontal and Endodontic Disease

Patients with incisor–premolar–molar malocclusion with periodontal and endodontic disease typically present with a history of noticeable weight loss (or even emaciation), ocular or nasal discharge, and/or maxillofacial abscessation (Figures 4 and 5). This disease complex may include the following components[13,16–18,20–23]:

- Incisor overgrowth/malocclusion occurs, as already described. In addition, apical overgrowth or "root elongation" occurs.

Figure 4. **Incisor–premolar–molar malocclusion with periodontal and endodontic disease (clinical aspects).**

Incisor malocclusion and coronally elongated premolars.



Extraoral abscessation.

- Irregularity of the premolar–molar occlusal plane occurs, resulting in a so-called "step-mouth," "wave-mouth," and/or sharp point or "spike" formation. Sharp points typically occur on the lingual aspect of the mandibular teeth and buccal aspect of the maxillary teeth.
- Intraoral elongation of premolars and molars occurs, with possible lingual or buccal deviation.
- Periodontal disease occurs, with increased mobility of, and pathologic diastema formation between, premolars and molars.
- Premolar–molar periapical changes occur, with apical elongation and possible cortical perforation.
- Soft tissue lesions associated with sharp points on premolars and molars develop on the oral mucosa.
- Submandibular, maxillofacial, or retrobulbar abscesses form.

It is unclear whether this disease complex has a genetic, dietary, or metabolic origin (or any combination of two or more of those factors). The pathophysiologic relationship among orthodontic, periodontal, and endodontic lesions is equally unclear. Not all patients show all components of the disease complex; however, even a relatively minor premolar–molar malocclusion should be considered an important clinical finding. It has been hypothesized that nutritional osteodystrophy caused by calcium and vitamin D deficiency is the main cause of advanced dental disease in rabbits.[16,20] It has recently been shown that affected animals have elevated parathyroid hormone levels and lower calcium levels.[24]

Therapeutic options for incisor–premolar–molar malocclusion with periodontal and endodontic disease may include:

- Occlusal adjustment of involved teeth
- Extraction of teeth severely affected by endodontic and/or periodontal disease
- Abscess debridement

In very severe cases, euthanasia may be considered. Although regular occlusal adjustments do not address some underlying lesions (e.g., apical elongation), normal chewing and tooth wear may be regained.[12]

ANESTHESIA

Preanesthetic Evaluation

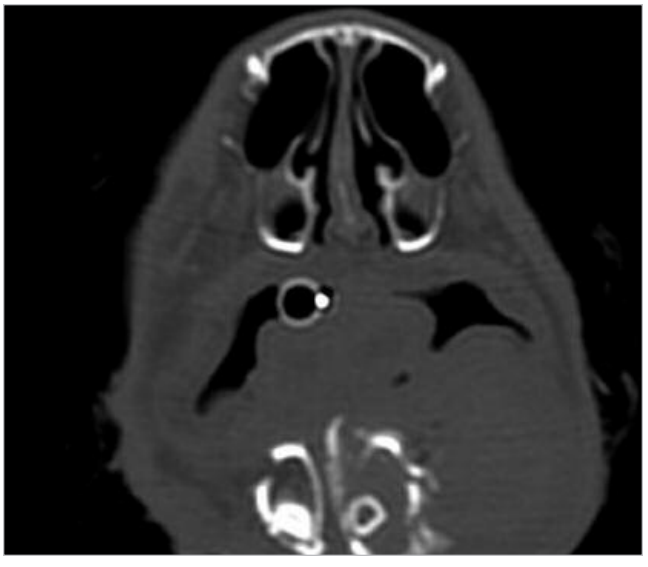
A preanesthetic evaluation is indicated in all dental cases when a procedure requiring general anesthesia is planned. This evaluation should ideally include a physical examination, complete blood cell count, and biochemical profile. Whole-body radiographs should be obtained if indicated.[25] A comprehensive evaluation is important because dental patients can have concurrent diseases (e.g., pneumonia, cardiac or renal disease), general debilitation, and/or severe gastrointestinal (GI) stasis due to dental disease. The concurrent problems may require additional supportive care to stabilize patients and reduce the anesthetic risk.[26] In addition, affected patients likely require frequent anesthesia to manage their dental disease, so a good understanding of their overall condition is important. Hematologic changes associated with dental disease are generally nonspecific

Figure 5. **Incisor–premolar–molar malocclusion with periodontal and endodontic disease (radiologic and CT findings).**

Incisor malocclusion with mild coronal elongation of the premolars and molars.

Apical elongation and near perforation of the mandibular premolars and molars.

Periapical changes, apical bone penetration, and abnormal premolar–molar occlusion.



Osteomyelitis of the mandible and associated soft tissue abscessation.

(e.g., anemia of chronic inflammation), but evaluating for such changes can be helpful in determining the severity of inflammation and assessing bone loss (e.g., elevated alkaline phosphatase).[27,28]

Preanesthetic Preparation

Debilitated patients must be stabilized before anesthesia, with particular attention to hydration, body temperature, GI tract function, nutrition, and pain management.[12,25,29] Preanesthetic recommendations vary regarding fasting rabbits; authors have recommended everything from no food withholding to up to 24 hours of food withholding.[25,26,30,31] Because rabbits do not vomit, prolonged fasting is generally not indicated.[26] A fasting time of 1 to 2 hours is satisfactory for most dental procedures; this is usually sufficient to ensure that the oral cavity is free of food during anesthetic induction.

Anesthetic Techniques

Several aspects of rabbit anesthesia for dental procedures are difficult, including intubating small rabbits, working in a small oral cavity with an orally placed endotracheal tube, inducing and maintaining inhalation anesthesia alone, and safely maintaining an adequate plane of anesthesia with parenteral anesthesia alone.

Although a thorough review of rabbit anesthesia is beyond the scope of this article, salient points regarding rabbit dentistry are discussed. More complete reviews of rabbit anesthesia can be found elsewhere.[25,26,29,30]

A balanced approach to anesthesia is indicated when conducting oral examinations and administering dental treatments in rabbits; the approach usually includes a combination of parenteral and inhalation anesthesia. Sedation is recommended before inducing anesthesia with an inhalation or injectable anesthetic. Sedation facilitates placement of a face mask for administering inhalation anesthesia, reduces the stress of induction on patients, and reduces the amount of anesthetic needed to maintain anesthesia, thus reducing secondary hypotension and respiratory depression.[29,31] We have found a premedication protocol of an opioid (usually butorphanol at 0.5 mg/kg IM) in combination with a benzodiazepine to be satisfactory; this protocol provides both analgesia and muscle relaxation. Midazolam (0.5 mg/kg IM) is the preferred benzodiazepine because it is water-soluble and therefore less irritating when administered intramuscularly compared with diazepam.[31] Parenteral anesthetic agents such as ketamine and xylazine or medetomidine or ketamine and a benzodiazepine can be used intramuscularly or intravenously to induce and potentially maintain anesthesia.[31–33] Because of the difficulty in intubating some rabbits, use of parenteral anesthetics, such as propofol and thiopental, that are likely to cause apnea is discouraged.[34] Parenteral anesthetic induction and maintenance protocols can have undesirable side effects, such as cardiovascular depression; in addition, depth of anesthesia can be difficult to control, especially if the intramuscular route of administration is used. Thus parenteral anesthetic protocols for maintaining anesthesia should be reserved for healthy rabbits in need of routine dental care such as occlusal adjustments. If parenteral anesthesia is selected for maintenance, supplemental oxygen should always be supplied to reduce the risk of hypoxia.[29]

Inhalation anesthesia can be used to induce anesthesia and is usually required to some degree to maintain anesthesia for dental procedures beyond the simplest occlusal adjustment.[31] Isoflurane and sevoflurane are our inhalation anesthetics of choice when working with rabbits. Patience is required when using inhalation anesthesia for induction because rabbits are prone to holding their breath[31]; in our experience, an induction time of 10 to 15 minutes is often required, during which the percentage of inhalation anesthetic provided via the vaporizer should slowly be increased until the appropriate anesthetic plane is reached. Premedicating patients, as already described, reduces difficulties encountered with anesthetic induction via an inhalation anesthetic.

Intubating rabbits can be difficult, but intubation has many advantages, such as control over ventilation and a means of protecting the respiratory tract from fluids being released into the oral cavity. Intubation is strongly recommended when invasive procedures such as multiple extractions are required. There are many references with good descriptions of how to safely and successfully intubate rabbits.[26,31,35] The disadvantage of oral endotracheal intubation is that the endotracheal tube may interfere with the dental procedure; nasal intubation is one solution to this problem. For nasal intubation, a small (i.e., 1 to 2 mm internal diameter) noncuffed endotracheal tube or a soft nasogastric tube can be passed into the ventral nasal meatus (Figure 6); a small amount of lidocaine should be instilled into the nostril before nasal intubation to reduce patient discomfort.[26,36] Occasionally, a tube cannot be placed into the nasal passages because of severe elongation of the incisors and secondary obstruction of the nasal passages.[26]

If the rabbit is not intubated, anesthesia can be maintained with an appropriately sized nose cone because rabbits are obligate nasal breathers[26] (Figure 6). Nose cones can be fashioned using 12- or 20-ml syringe cases with a latex glove fitted over the end as a diaphragm; a proper scavenging unit at the end of the nonrebreathing circuit and a well-fitted nose cone are necessary to limit human exposure to inhalant anesthetics.[30,37]

Anticholinergic agents can be used as needed to reduce respiratory secretions and bradycardia. Glycopyrrolate is

Perioperative care, including management of pain, hydration, nutrition, and secondary infection, is crucial to a favorable outcome for rabbits with dental disease.

the anticholinergic of choice in rabbits because of the high incidence of endogenous atropinases in this species.[29]

Careful patient monitoring during anesthesia is essential.[38] At a minimum, body temperature, heart rate, and respiratory rate and character should be monitored. Because body temperature can decrease rapidly in small patients, external heat should be provided with heat lamps and/or warm-water or forced-air blankets. The heart rate can be easily monitored with a stethoscope or Doppler ultrasound probe. Hypoventilation is common, and apnea can be fatal in nonintubated patients; thus respiration can be carefully monitored visually and oxygenation can be monitored with pulse oximetry.[30] Many deaths attributed to anesthesia could likely be avoided by paying careful attention to patient ventilation. Anesthetic depth and head position (Figure 6) should be adjusted as needed to maintain adequate ventilation.

PERIOPERATIVE SUPPORTIVE CARE

Perioperative supportive care is just as crucial to a good outcome for rabbits with dental disease as is the dental treatment. Pain, hydration, nutrition, and secondary infections must be considered thoroughly.[37,39]

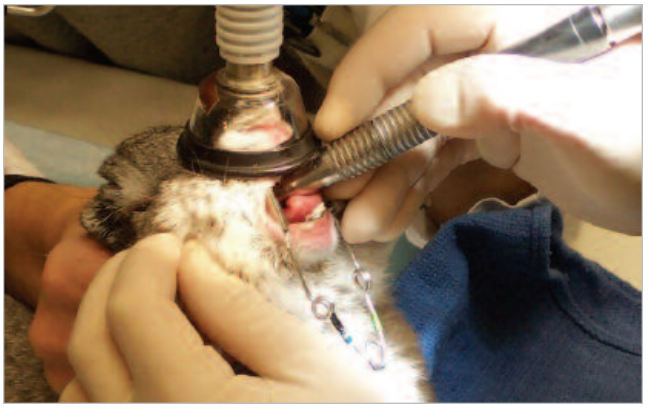
Perioperative pain management is essential and can be achieved with a combination of opioids and NSAIDs.[26,40] Pain can be difficult to recognize in rabbits but can have significant adverse effects, such as reduced food and water intake and GI stasis.[26,31,41] Opioids and NSAIDs can be used together as needed in the immediate postoperative period, whereas NSAIDs can be prescribed for home use. For a routine occlusal adjustment, a single dose of an opioid is often sufficient, whereas NSAIDs can be continued for 3 to 5 days.[42,43] Consideration must be given to the potential adverse effects of NSAIDs, such as GI ulceration and renal blood flow reduction.[41,44] If a major procedure (e.g., incisor extraction) has been performed, several days of opioid analgesia may be needed.[26] Although many opioids have been used in rabbits, butorphanol and buprenorphine are preferred to pure μ-agonists (e.g., morphine, oxymorphone), which carry an increased risk of inducing ileus.[42,45]

Rabbits with dental disease and oral pain after a dental procedure often reduce their water intake[26]; therefore, hydration must be monitored closely. Although fluids can be provided intravenously and intraosseously if needed, subcutaneous fluid therapy is often sufficient; the recommended maintenance dose is 50 to 100 ml/kg/day of a balanced replacement fluid.[26,46,47] Using a 19- to 21-gauge butterfly catheter or a fluid extension set increases ease of administration of subcutaneous fluids and reduces the amount of restraint required.

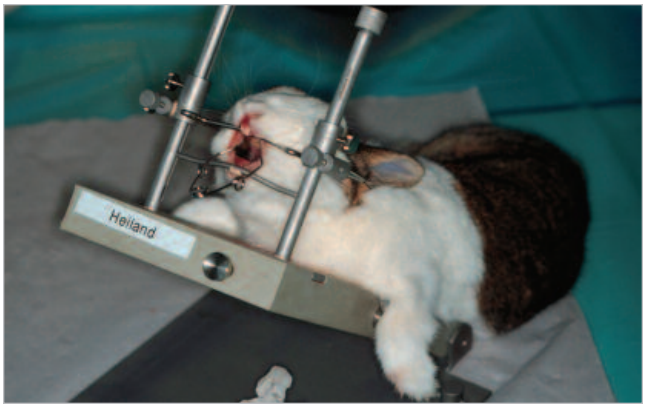
Nutrition and GI function must also be addressed. Rabbits may not eat because of severe dental disease or

Figure 6. Positioning and anesthesia.

A rabbit in dorsal recumbency with nasal intubation, head support from an assistant, and a mouth gag and pouch dilator in position.



Dental treatment with anesthesia maintained using an anesthetic mask over the nose.



An operating platform specially designed for small mammal dentistry. (Courtesy of Dr. P. Fahrenkrug)

Figure 7. Oral examination of a nonanesthetized rabbit using a lighted bivalve nasal speculum.

discomfort secondary to dental treatment. Regardless of the cause, anorectic patients must be given nutritional support.[47,48] Syringe feeding a timothy hay–based, balanced herbivorous diet (50 ml/kg/day) is preferred.[49] If such a diet is not available, another option is feeding a gruel made of a soaked pelleted diet that has been in a blender.[26,49] Syringe feeding vegetable baby food is discouraged because it is not a balanced diet and does not have the necessary fiber content to promote normal GI function in rabbits. Some patients may eat soaked pellets or a syringe-feeding diet directly from a dish in their cage.[26] Syringe feeding is often needed for 3 to 5 days after a dental treatment; however, long-term feeding may be needed in cases of severe dental disease.[48] Although nasogastric, pharyngostomy, and percutaneously placed gastrostomy feeding tubes can be used in rabbits, they can be cumbersome to maintain, have a greater risk of complications compared with use in carnivores, and are often not needed.[26,47,50]

In addition to anorexia, GI stasis commonly accompanies dental disease and its associated treatments. GI stasis can be managed with an appropriate diet, hydration, pain management, and prokinetic drugs such as metoclopramide (0.5 mg/kg PO or SC q12h) or cisapride (0.5 mg/kg PO q12h).[26,51] When treating rabbits, there is the inherent problem that GI stasis can be caused by both pain and ileus-inducing opioids used for pain management; therefore, when appropriate, pain should be managed with NSAIDs that can be accurately dosed in rabbits.

Secondary infections must be treated. Facial abscesses are frequently associated with dental disease, but infection of oral ulcers, bacterial rhinitis, dacryocystitis due to elongated apices, and even pneumonia can occur secondary to dental disease. Appropriate antibiotic treatment should be selected based on aerobic and anaerobic culture and sensitivity of the abscess capsule, nasal discharge, nasolacrimal duct flush, or, if possible, ultrasound-guided fine-needle aspiration of consolidated lung lobes.[48] In rabbits, these abscesses have been found to contain both aerobic and anaerobic pathogens, so antimicrobials must be appropriate.[43,48,52] Broad-spectrum antibiotics are considered ideal, but choices are limited in rabbits because of the risk of fatal dysbiosis.[41] In one study,[52] 100% of facial abscess pathogens identified were susceptible to chloramphenicol, 96% to penicillin, 86% to tetracycline, 54% to metronidazole and ciprofloxacin, and only 7% to trimethoprim–sulfamethoxazole. We have found chloramphenicol (30 to 50 mg/kg PO or SC q12h), procaine–benzathine penicillin G (40,000 to 60,000 U/kg SC q48h), and enrofloxacin (5 to 15 mg/kg PO, SC, or IM) to be the most clinically useful antibiotics when treating infections secondary to dental disease in rabbits.[53,54] Clients must be warned of the risk of aplastic anemia in humans with home use of chloramphenicol as well as the risk of dysbiosis or anaphylaxis in rabbits when penicillin injections are used.[26,55] The duration of therapy depends on the site and source of infection. Infected oral ulcers may require a relatively short treatment duration (i.e., 10 to 14 days), whereas facial osteomyelitis may require many months of antimicrobial therapy.

DENTAL TECHNIQUES

Oral Examination

Rabbits typically have a small mouth opening and a long, narrow oral cavity, making complete oral examinations difficult in conscious patients. In addition, rabbits are generally easily stressed by manual restraint. A cursory examination can be performed using an otoscope, a lighted nasal speculum, or a videootoscope[16,56] (Figure 7).

Routine use of general anesthesia is recommended for oral examination, minor procedures, and major oral surgery. Inhalation anesthesia can be administered using a face mask for oral examination and minor procedures,

Figure 8. Tooth-height reduction of incisors using a cylindrical diamond bur on a high-speed handpiece.

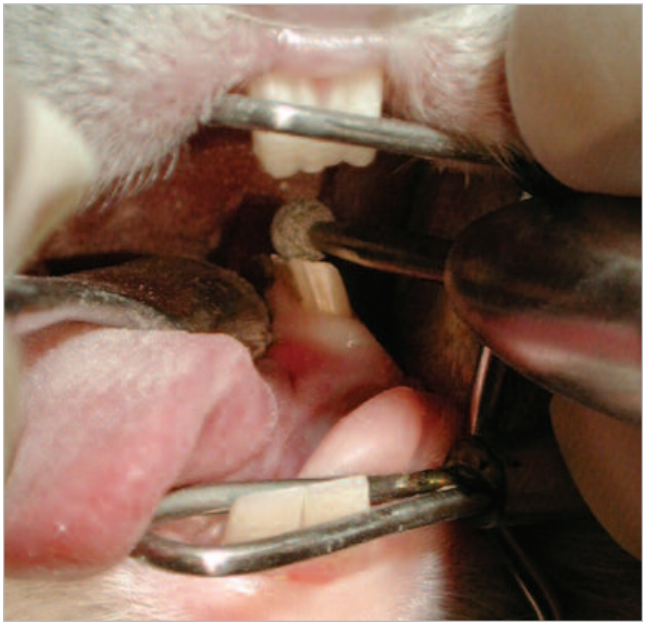


Figure 9. Occlusal adjustment of mandibular premolars and molars using a round diamond bur on a straight handpiece.

such as incisor crown-height reduction (Figure 6). Extractions, abscess debridement, and other major oral surgery should be performed only with proper endotracheal intubation, venous access for fluid administration, and adequate anesthetic monitoring. Nasal endotracheal intubation is preferred to oral intubation because the workspace and visibility are much better (Figure 6).

Oral examination is greatly facilitated by using oral speculums specifically designed for rabbits and rodents. One speculum should be placed between the incisor teeth, opening the mouth in a vertical plane, and a second speculum, known as a *pouch-dilator*, should be placed perpendicular to the first one to open the mouth in a horizontal plane (Figure 6). Alternatively, patients can be placed on an operating platform with an attached speculum (Figure 6). Good lighting, magnification, and suction facilitate the oral examination. With the oral cavity opened by speculums, the tongue should be gently retracted and the dental quadrants inspected. Care should be taken not to lacerate the tongue on the mandibular incisors. Using a periodontal probe and dental explorer is indicated to assess tooth mobility and increase probing depth.

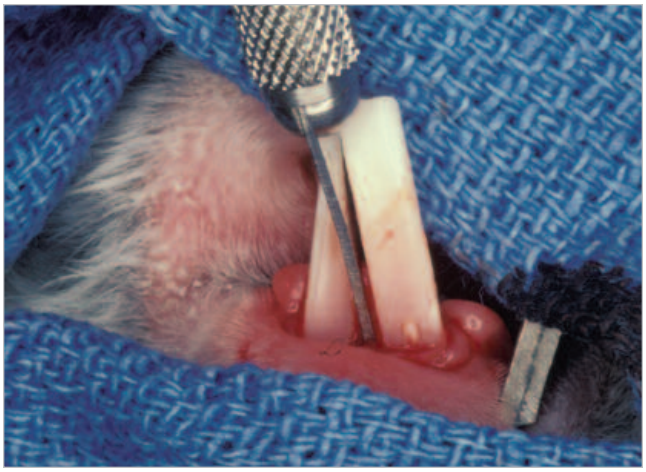
Radiography

Radiography is an essential part of a comprehensive oral examination. Skull radiography is an extremely useful diagnostic tool in patients suspected of having malocclusion, periapical lesions, or bone disease. The small size of rabbits and the superposition of dental quadrants make radiologic interpretation difficult. Magnified radiographic studies can be obtained using radiography units with a very small (i.e., 0.1 mm) focal spot and 100-mA capability. The tube should be brought relatively closer to the patient (decreasing the source object distance) and the film farther from the patient (increasing the object imaging device distance) at about the same source imaging device distance as for standard radiography. The magnification is the source imaging device distance divided by the source object distance, and a magnification of up to three times can be obtained. Alternatively, high-resolution mammography film or dental film can be used. Laterolateral, dorsoventral, and two oblique views are recommended to fully evaluate the teeth, maxillae, and mandibles. Occlusal views, although desirable, are difficult to obtain and interpret. In one report,[57] computed tomography (CT) was found to be more useful in diagnosing dental problems in chinchillas than was conventional radiography. In a recent similar study in rabbits,[58] neither radiography nor CT was clearly superior, but the two modalities provided complementary diagnostic information.

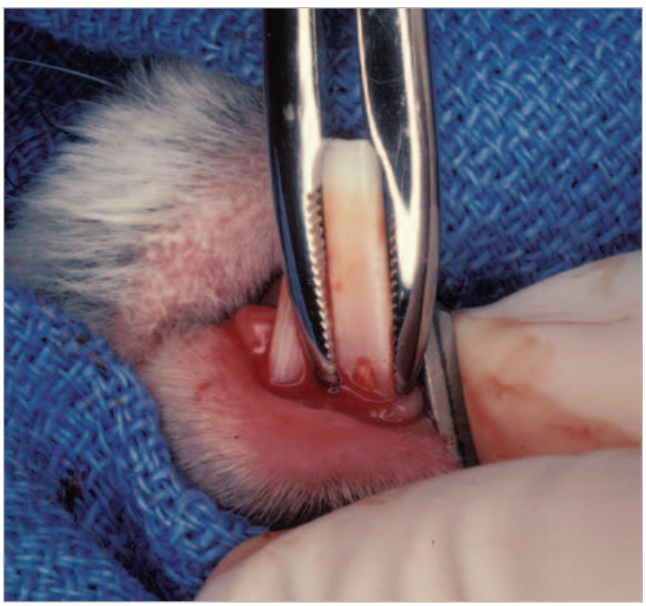
Tooth-Height Reduction

Tooth-height reduction of incisors can be performed using a cylindrical diamond bur on a high-speed handpiece[23] (Figure 8). Care should be taken to avoid thermal damage to the pulp: A very light touch should be

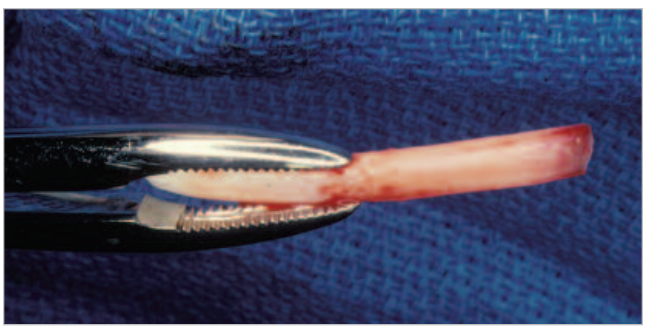
Figure 10. Incisor extraction in a rabbit. (Reprinted with permission from Verstraete FJM: Advances in diagnosis and treatment of small exotic mammal dental disease. *Semin Avian Exot Pet Med* 12[1]:37–48, 2003.)



A small straight luxator inserted into the mesial aspect of the tooth.



Forceps delivery of the luxated tooth.



Checking the extracted tooth to ensure that all of it was removed.

used to avoid having to use cooling fluid; alternatively, the oropharynx can be packed if an endotracheal tube is used. A tongue depressor can be placed behind the incisors to stabilize the jaws and protect the lips and tongue. Care should be taken to restore the normal occlusal plane angulation. If tooth-height reduction is correctly performed, pulp exposure should not occur; however, if it does, partial pulpectomy and direct pulp capping are indicated. An intermediate restorative material should be used for filling the pulp cavity opening; harder materials such as composites are not indicated because they may interfere with normal attrition.[12]

Using a cutting disk on a straight handpiece or a Dremel tool (Racine, WI) is not recommended because soft tissues can be easily traumatized. Nail trimmers and wire cutters are contraindicated because they can fracture and split teeth, possibly exposing the pulp. This is not only very painful but also may lead to periapical pathosis.[12,59]

Occlusal Adjustment

Occlusal adjustment of the premolars and molars, including height reduction and smoothing sharp points and spikes, can be safely performed using a round diamond bur on a straight handpiece[23] (Figure 9). A rabbit and rodent tongue spatula or regular dental cement spatula can be used for retracting and protecting oral soft tissue. Alternatively, a specially designed bur guard that fits on certain straight handpieces can be used.[12] Small handheld files are not very effective and tend to cause soft tissue trauma. Care should be taken to restore the normal occlusal plane angulation and to check premolar–molar and incisor occlusion during the procedure. If a practitioner is not familiar with the normal anatomy and occlusion, it is advisable to have normal skull specimens available for reference. Following an extensive occlusal adjustment with height reduction, it may take several days for the masticatory muscles to adapt before they can contract sufficiently to bring the teeth into occlusal contact.[12] Nutritional support and pain management may be required during this period.

Extraction Techniques

Incisor Extraction

Incisor extraction may be complicated by long teeth but can generally be achieved by nonsurgical means (Figure 10). Very careful luxation is the technique of choice. A specially designed, curved rabbit incisor luxator is available (Crossley rabbit incisor luxator, Veterinary Instrumentation, Sheffield, UK, and Jorgensen

Laboratories, Loveland, CO).[12] Small, sharp, straight luxators can also be used for this purpose.[23] Alternatively, flattened and bent, suitably sized hypodermic needles can be used.[60] After the epithelial attachment has been cut with a small scalpel blade, the luxator should be carefully inserted into the periodontal space and gradually moved in an apical direction, concentrating on and alternating between the mesial and distal aspect of the tooth. Some expansion of the alveolar bone plate invariably occurs, but care should be taken to limit this and avoid leverage. Once the periodontal ligament has been severed, the tooth will slide out of the alveolus along the curved growth path. This can be facilitated by using a suitably sized extraction forceps. However, because of the curvature of these teeth and their trapezoid cross-section, rotational movements with the extraction forceps are not indicated. Slight longitudinal traction is appropriate in the final stage of the extraction. Before doing this, the tooth can be gently intruded into the alveolus; this is believed to dislodge the apical germinal tissues.[12] Failure to do this may result in regrowth of the tooth or formation of mineralized dental tissue in the vacated alveolus.[12,61]

Leverage, torque, and premature longitudinal traction may lead to iatrogenic tooth fracture. A retained tooth tip generally causes the tooth to regrow if the pulp remains vital. Preexisting periapical lesions cannot resolve in the presence of a retained tooth tip. It is advisable to remove the six incisors if the treatment objective is to prevent incisor malocclusion. If a single incisor must be extracted (e.g., for a complicated crown fracture with pulp necrosis), it is generally not necessary to extract the opposing incisor. The lateral movement of the occlusion is sufficient to evenly wear the remaining incisors.

Premolar and Molar Extraction

Extraction of premolars and molars is difficult because of the size of the embedded portion of the teeth, limited access, and close proximity of the teeth. The bone plate separating the alveoli from the nasal cavity and orbit and the mandibular cortex overlying the alveoli are very thin, making iatrogenic damage easily possible, especially if bone lysis is present as a result of the dental disease. Various techniques have been described for extracting premolars and molars[1,12,62]:

- The extraoral surgical approach (similar to repulsion in horses)
- The buccotomy approach (incising the cheek to gain access)
- The intraoral nonsurgical technique

The latter technique requires considerable skill and patience but is less traumatic. A specially designed rabbit molar luxator can be used to carefully loosen a tooth on the mesial, distal, buccal, and lingual aspects. Only when the tooth is very mobile can specially designed molar extraction forceps (Veterinary Instrumentation) be used for final delivery. It must be emphasized that extraction of aradicular hypsodont teeth not only is technically difficult but also requires considerable anesthetic and nursing care support, which may make referral a better option.

Incisor–premolar–molar malocclusion is a common disease complex in rabbits.

Perioperative and postoperative antibiotic treatment is indicated for patients requiring extraction because of the traumatic nature of the procedure and the extent of preexisting dental disease. The type, dose, and duration of administration of any antibiotic must be chosen carefully for rabbits. Otherwise, antibiotic-associated diarrhea and other serious complications may occur. Nutritional support is often indicated.

Treatment of submandibular abscessation should include thorough debridement, extractions as indicated, and long-term antibiotic therapy, preferably based on bacterial culture and sensitivity. It is important to note that soft tissue abscesses and osteomyelitis associated with periapical lesions or with combined periodontal–endodontal lesions are unlikely to resolve if the affected teeth remain in place. An alternative method of treatment is to pack the abscess cavity with calcium hydroxide paste.[63] Irreversible dental problems often remain untreated with this method; therefore, and because of the caustic nature of calcium hydroxide paste, this technique is not recommended. Antibiotic-impregnated

polymethyl–methacrylate beads are a more tissue-friendly alternative.[22]

RECOMMENDATIONS TO CLIENTS

Clients must be counseled on managing pets with dental disease. In cases of mild disease, encouraging rabbits to eat an appropriate diet can reduce progression of dental disease.[26] For example, converting rabbits to a diet consisting primarily of timothy or other grass hay as well as grass and fibrous vegetables rather than a primarily pelleted diet can encourage increased chewing and appropriate attrition of the teeth.[26] In more severe cases, return to a normal diet may not be possible and all that can be done is to find a balanced diet that affected animals are able to eat, such as soaked pellets and formulated syringe-fed diets.[26] Clients must also be taught what clinical signs to watch for as indicators that their pet is having problems with its teeth, such as dropping food, reduced appetite, smaller fecal pellets, and ptyalism. Clients must be educated about the chronic nature of dental disease in rabbits because education early in the course of treatment can prevent frustrations later if a pet needs to return to the clinic for treatment every 4 to 12 weeks for the rest of its life.

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ARTICLE #2 CE TEST

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1. The so-called "peg teeth" in rabbits are the

a. maxillary second incisors.
b. vestigial maxillary first premolars.
c. rudimentary maxillary canine teeth, which are most often found in male rabbits.
d. supernumerary maxillary molars distal to the third molars.

2. The occlusion of rabbits is characterized by a

a. maxillary arch that is wider than the mandibular arch and a horizontal occlusal plane.
b. mandibular arch that is wider than the maxillary arch and a horizontal occlusal plane.
c. maxillary arch that is wider than the mandibular arch and an occlusal plane angled at about 10° toward horizontal.
d. mandibular arch that is wider than the maxillary arch and an occlusal plane angled at about 10° toward horizontal.

3. Which statement regarding inhalation anesthesia in rabbits is incorrect?

a. Inhalation anesthesia can be maintained in rabbits via an orally or nasally placed endotracheal tube.
b. Inhalation anesthesia in rabbits cannot be maintained via a nose cone because rabbits are obligate oral breathers.
c. Because rabbits are prone to holding their breath, patience is required when using inhalation anesthesia for induction.
d. Intubation is strongly recommended when invasive procedures, such as multiple extractions, are required.

4. If a dental-associated maxillofacial abscess in a rabbit is being treated empirically, which antibiotic(s) would be least effective?

a. procaine–benzathine penicillin G
b. chloramphenicol
c. ciprofloxacin combined with metronidazole
d. trimethoprim–sulfamethoxazole

5. Which of the following is not an essential component of managing GI stasis in rabbits with dental disease?

a. maintaining appropriate hydration
b. managing pain
c. providing a low-fiber, highly digestible diet to reduce the workload of the GI tract
d. providing the necessary fiber because it is essential to normal GI function in rabbits

6. Why is glycopyrrolate preferred over atropine as an anticholinergic agent in rabbits?

a. Rabbits have a high incidence of endogenous atropinases, which reduces the duration of action of atropine.
b. Glycopyrrolate is less likely to have GI side effects.
c. Glycopyrrolate is less potent than atropine and therefore less likely to cause adverse effects.
d. Glycopyrrolate has a more rapid onset of action and is therefore more helpful in a crisis.

7. Which clinical sign(s) is not commonly associated with dental disease in rabbits?

a. weight loss and small fecal pellets
b. maxillofacial abscesses
c. ocular and/or nasal discharge
d. ear canal discharge

8. Which statement regarding the deciduous teeth of rabbits is correct?

a. The deciduous first incisors are generally shed around birth and go unnoticed; the deciduous second incisors and premolars are present at birth and exfoliate within a month after birth.
b. The first incisors do not have deciduous precursors; the deciduous second incisors and premolars are present at birth and exfoliate within a month after birth.
c. All deciduous incisors and premolars are present at birth and exfoliate within a month after birth.
d. The deciduous first incisors and premolars are present at birth and exfoliate within a month; the deciduous second incisors are generally shed around birth and go unnoticed.

9. Which instrument is preferred for tooth-height reduction of the incisors?

a. guillotine-type nail trimmers
b. tungsten-tipped wire cutters
c. a Dremel tool
d. a high-speed handpiece with a cylindrical diamond bur

10. Which combination of odontologic terms is applicable to the premolars and molars in rabbits?

a. elodont, aradicular hypsodont, lophodont
b. anelodont, aradicular hypsodont, lophodont
c. elodont, radicular hypsodont, bunodont
d. anelodont, aradicular brachydont, selenodont