Gastrointestinal Diseases of Pet Rabbits
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Gastrointestinal disease is the most common reason that pet rabbits are presented for veterinary evaluation and treatment. Most of the problems affecting a house rabbit’s gastrointestinal health are caused by hereditary or husbandry factors, many of which can be managed with basic veterinary procedures and appropriate diet. Copyright © 1999 by W. B. Saunders Company.

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Signs consistent with gastrointestinal (GI) disease in pet rabbits can include lethargy, anorexia, hypersalivation or drooling, submandibular masses, diarrhea, constipation, tenesmus, bruxism, ileus, abdominal masses, distention or pain during palpation, and fecal soiling. Differential diagnoses for GI signs should include inappropriate diet (usually too low in fiber or too high in carbohydrates), dental malocclusion, dehydration, and parasitism, as well as non-GI conditions such as neoplasia (eg, thymoma, uterine adenocarcinoma), urinary tract calculi, and trauma (especially musculoskeletal or neurological).

Anatomy and Physiology

Rabbits have open-rooted (continuously growing) incisors, premolars, and molars, with the dental formula of 2(1:1-2/1, C:0/0, P:3/2, M:2-3/3) = 26-28. Some pet rabbits do not have a second pair of upper incisors, or “peg teeth.” The premolars and molars are far more necessary than the incisors for normal side-to-side grinding and mastication of fibrous food. A diastema exists between the incisors and “check teeth” (premolar and molars). The intermaxillary space is greater than the intermandibular space, as in horses; therefore, premolar and molar malocclusion often involves lateral (buccal) overgrowth of the maxillary teeth and medial (lingual) overgrowth of the mandibular teeth. In the awake rabbit, the angle of opening of the oral cavity is quite small.

Rabbits have a simple stomach with a well-developed cardiac sphincter that anatomically precludes the ability to vomit. Masses of food and hair are normally present in a rabbit’s stomach, but with normal GI function, these masses are eventually passed along the GI tract for excretion. The stomach is never empty in a normal rabbit; gastric emptying time may be as long as 3 days. Gastric pH is normally 1 to 2 in the mature rabbit, which kills most microorganisms; suckling rabbits’ gastric pH is 5 to 6.5, however, which allows the hindgut to develop its normal bacterial population, but also makes young rabbits vulnerable to bacterial enterocolitis.

The small intestine of rabbits has similar anatomy and physiology to other familiar species. The pylorus, proximal duodenum, and ileocecal area are potential sites of GI obstruction. A gall bladder is present on the right medial lobe of the liver. The hindgut (cecum and colon) has important roles in digestive physiology, including selective separation and rapid excretion of fiber, fermentation of remaining nutrients in the cecum, and production of cecotropes (also called “cecal pellets” or “night feces”), which are later consumed by the rabbit for conservation of beneficial microbes and vitamins B and K. Cecotropes are covered with mucus, which protects them from gastric acid for at least 6 hours, therefore allowing fermentation and lactic acid production within the cecotropes to continue.

Nutrition

Alfalfa-based pellets typically available in pet stores were originally designed to be fed to production rabbits (those raised for meat or fur purposes), therefore their protein content is higher and fiber content is lower than would be ideal for pet rabbits. Higher-than-ideal protein levels will cause a decrease, then an increase in cecal pH, allowing pathogenic bacteria to prolif-
erate there. Lower-than-ideal levels of indigestible fiber will cause cecal hypomotility and predispose the rabbit to enteritis and diarrhea. An absolute minimum of 10% dietary crude fiber has been recommended in production rabbit feeds. Because of differences in fiber use by different rabbit breeds, it is impossible to specify fiber requirements for pet rabbits, but the fact remains that adequate fiber is extremely important for rabbit GI health, and it is probably safe to recommend that rabbit owners choose diets containing the highest fiber available. Most pet rabbits do best when fed a grass hay-based diet.

### Gastrointestinal Conditions

#### Dental Malocclusion

A thorough discussion of history and a careful physical examination are important for evaluation of oral disease. Animals with painful teeth, jaws, or oral mucosa will be reluctant to eat, or might not be able to smell, prehend, chew, or swallow food well. Owners may notice that their rabbit is steadily losing weight, although food gets scattered around its cage. Body fur might appear unkempt, if a painful rabbit is no longer using its mouth for grooming. Maxillary or mandibular abnormalities may be palpable or evident during initial visual examination, before they seem to affect the rabbit’s behavior or appetite. Hypersalivation can have many causes, including oral soft tissue disease; drooling might not be obvious, but there may be other signs such as wet front paws. Halitosis can be a sign of intraoral infection.

During your physical examination, it is important to palpate for asymmetry and/or pain in the rabbit’s mandibles, maxillae, and overlying subcutaneous tissue. Lift the lips to examine incisor length, occlusion, and color. Use an otoscope with medium to large cone attached to examine the premolars and molars; do this by holding the rabbit’s head stationary with one hand and directing the otoscope through the diastema into the mouth for a lighted view of the oral cavity (Table 1). Most rabbits object to the otoscope procedure (and their lips and tongue often obstruct your view); therefore, be prepared to work quickly. The intraoral examination of a rabbit should include evaluation of premolar/molar positioning and length, any protruding “points” (usually on the rostral aspect of premolars, buccal surfaces of the maxillary teeth, or lingual surfaces of the mandibular teeth), exudate or bleeding, and any lacerations or ulcers or white plaques on the adjacent mucosa. If the rabbit is anesthetized for the examination, a blunt probe can also be used to evaluate each tooth for looseness.

Malocclusion is the most common dental abnormality seen in pet rabbits. Incisor malocclusion usually presents as prognathism, in which the mandibular incisors grow rostral to the

<table>
<thead>
<tr>
<th>Table 1. Useful Tools for Gastrointestinal Evaluation and Treatment in Rabbits</th>
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<tr>
<td>Otoscope with large cone (for examining cheek teeth), or nasal speculum with integrated light source</td>
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<tr>
<td>Lempert (small-tip) rongeurs</td>
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<td>Small thin rasps</td>
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<td>Wire cutters with fine sharp tips</td>
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<td>Dremel moto-tool with circular cutting tip, protective eyewear and mask</td>
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<td>Dental handpiece</td>
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<td>Tongue depressors (break in half to make them narrower)</td>
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<td>Long cotton-tip applicators</td>
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<td>Pouch retractors, cheek dilators, human eyelid retractor, or vaginal speculum</td>
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<td>High detail radiographic equipment, ideally with magnification ability</td>
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<td>Complete blood cell count (CBC) and chemistry panel collection supplies</td>
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<td>Fecal parasite examination supplies</td>
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<td>Cytological examination supplies</td>
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<td>Microscope</td>
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<td>Swabs for sample collection for aerobic, anaerobic, and fungal culture/sensitivity testing</td>
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<td>Reference laboratory familiar with rabbit blood handling, cultures, parasite examinations, and cytology</td>
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<td>Food blender</td>
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<td>Variety of food items including formulated diets, hay, vegetables, baby food, liquid diets, active culture yogurt, source of healthy rabbit feces or cecotropes</td>
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<td>Red rubber feeding tubes 8 French (Fr) and smaller</td>
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<td>Elizabethan collars (ca-size and smaller)</td>
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<td>Intravenous catheters (20-gauge and smaller)</td>
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<td>Spinal needles for intraosseous catheterization (20- and 22-gauge)</td>
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<td>Transparent chamber for anesthetic induction</td>
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<td>Heating pad, stockinette, towel, or bubble wrap to counteract hypothermia</td>
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<tr>
<td>Isoflurane anesthesia machine</td>
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<tr>
<td>Small-diameter endotracheal tubes, sizes 2.0 mm to 3.0 mm, uncuffed</td>
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<tr>
<td>Laryngoscope with narrow blade</td>
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<tr>
<td>Long 3.5-Fr polypropylene catheters</td>
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<td>Up-to-date exotic animal formulary and stocked pharmacy</td>
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<td>Small volume syringes (&lt;1 mL) and needles 25 gauge (ga) or smaller</td>
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maxillary incisors; this results in overgrowth of all incisors. Normally, the mandibular incisors of rabbits should be worn down by occlusion with the "peg teeth" caudal to the first set of maxillary incisors. Inheritance of prognathism likely accounts for its high incidence rate in rabbits. Other causes for malocclusion include jaw trauma or apical jaw abscesses. Malocclusion and overgrowth can also be seen in premolar and molar teeth; this is not always coincident with incisor malocclusion, but can result from incisor malocclusion.

Treatment of malocclusion traditionally involves periodic trimming of affected teeth every 1 to 2 months, because rabbits' incisors grow up to 1 cm per month. There are varying opinions about which tool(s) should be used for incisor trimming; available options include wire cutters, dog nail trimmers (Resco; Tecla Co, Walled Lake, MI), low- or high-speed dental handpiece, or a rotary power tool (Dremel Multipro; Dremel Co, Palm Springs, CA) with a diamond disk or bur attached. It is often stated that teeth may split and shatter longitudinally when wire cutters or nail trimmers are used to trim incisors, therefore the power equipment methods are preferable, but some practitioners do not regard this as a major risk, especially if hand trimming equipment is sharp. If incisors do shatter, apical abscessation and/or maldirected incisor growth is likely in the future, and incisor extraction will become necessary.

Dental radiographs are recommended before extraction, especially if infection or involvement of other teeth or bone is suspected. An 18-gauge needle, #15 scalp knife, or small-breed elevator/root tip pick elevator is used to break down periodontal ligaments, starting with the lower incisors. The medial ligament of each tooth is the most important one to loosen. Insert the elevator deeply to the level of the bony alveolus, rotate it, and hold that position for 10 seconds. Repeat this technique at the lateral, buccal, and lingual aspects of the same tooth, then grasp the tooth and pull gently and firmly in the direction (arc) of tooth growth. If the tooth is extracted completely, its base should appear as a hollow tube. Upper incisors are extracted in a similar manner, but they are more curved. Hemostasis is usually not a major concern during incisor extraction, and it is not necessary to pack tooth sockets with antibiotic or other material postextraction, although it is wise to flush the sockets with dilute chlorhexidine solution postextraction for mechanical removal of debris. Take the opportunity to culture the sockets for aerobic and anaerobic bacteria if you are concerned about tooth root infection, and consider whether at-home flushing of the sockets should be prescribed. Rabbits can be offered their normal food (including hay) postoperatively, but should also be offered a water-soaked version of their normal food. Postoperative analgesia (butorphanol 0.1 to 0.5 mg/kg intravenously or subcutaneously every 4 hours, or buprenorphine 0.01 to 0.05 mg/kg subcutaneously, intramuscularly, or intravenously every 6 to 12 hours, or flunixin meglumine 1.1 mg/kg subcutaneously or intramuscularly every 12 hours or fentanyl 12.5 μg by patch) is important to encourage early return to normal eating behavior. Be aware that the "peg teeth" are often broken during extraction of the upper incisors. If the peg teeth or any other incisors are broken during surgery, they should be allowed to grow again for approximately 6 to 8 weeks and then extracted.

Premolar and molar malocclusion can be primary in origin, secondary to trauma, or secondary to chronic incisor malocclusion and overgrowth (Fig 1). These teeth (or their "points") are trimmed in an anesthetized patient using small rongeurs, a small file, or ideally, a high-speed dental handpiece. Because the oral cavity is so narrow, it is difficult to see affected teeth clearly and protect adjacent soft tissue structures; a focal light source and an assistant or specialized retractors are necessary for this procedure (large size rabbit/rodent pouch dilator and rodent incisor gag, available from Dr Shipp's Laboratories, Beverly Hills, CA). Severely maloccluding cheek teeth may result in apical migration of the maxillary tooth roots toward the orbit or deeper into the mandible, causing palpable exostoses on the mandible. If periodontal disease and malocclusion are this severe, extraction of the offending cheek teeth is indicated. Extraction of premolar or molar teeth should be accomplished using an intraoral approach; nasotracheal intubation with a 2.0-mm endotracheal tube will be necessary for this procedure. Blood transfusion may be indicated during extraction of cheek teeth, especially if there has been chronic inflammation or extensive surgical trauma. Gingival closure should be attempted after cheek tooth extraction, using 4-0 or smaller.
absorbable suture, to decrease bacterial invasion of underlying soft tissues and bone.

Mandibular abscessation is fairly common in rabbits and carries a grave prognosis for cure. Radiographs will show expansile destruction, lysis, and sclerosis in the area of inflammation (Fig 1). The bony changes usually result from extension of an apical abscess (often caused by cheek tooth malocclusion) or subcutaneous abscess. Treatment involves aggressive surgical debridement (including tooth extraction) and long-term antibiotic therapy, but recurrence of abscessation is extremely common. Gelfoam saturated with antibiotics such as ceftiofur, or methylmethacrylate beads impregnated with antibiotics such as amikacin, have been used to fill the area after curettage in an attempt to provide high antibiotic levels locally in surrounding tissue. A controversial but potentially more successful treatment option for mandibular abscesses includes use of calcium hydroxide paste59; after debridement and cleaning of the abscess cavity, the cavity is filled with calcium hydroxide paste, which is bactericidal due to its pH of 12.0. The paste is removed after 1 week and replaced if purulent material is again seen.

Figure 1. Lateral skull radiographs of two anesthetized adult rabbits. (A) Mandibular osteopenia, tooth loss, incisor malocclusion, premolar malocclusion, and molar malocclusion ("wave mouth"). This radiograph was made 2 years after mandibular trauma occurred in this rabbit. Mandibular abscessation in rabbits is often associated with these radiographic findings. (B) Normal dental and mandibular appearance. The left zygomatic arch and left orbit show radiographic evidence of bony lysis and sclerosis, as an inflammatory response to an orbital mass.
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Gastric Trichobezoars (Hairballs)/Ileus

Historically, gastric trichobezoars have been described as the most important and common GI condition afflicting pet rabbits. This may be true, but theories as to cause, and therefore treatment, have changed substantially over the past several years. Originally believed to be caused by overgrooming and subsequent presence of large amounts of hair in the stomach, this condition is now believed to be secondary to abnormal GI physiology and motility, which itself is secondary to dehydration or a diet of low fiber content. As mentioned earlier, masses of hair are typically present in a rabbit’s stomach and are eliminated with normal peristaltic activity of the entire GI tract. If gastric pH is increased or peristalsis is decreased (ileus) as a result of GI or extra-GI illness, masses of hair and food will accumulate in the stomach and can eventually cause true pyloric or proximal duodenal obstruction, with gastric tympany and mucosal (or more severe) damage.

Treatment of this condition should be aimed at reestablishment of adequate hydration, GI motility, and gastric pH. Fluid therapy (lactated Ringers solution 150 mL/kg/day), metoclopramide (0.5 mg/kg given orally or subcutaneously every 8 hours), cisapride (0.5 to 1.0 mg/kg given orally once daily), mineral oil, cat laxatives, B vitamins, and force-fed blenderized alfalfa pellets, fruits, and vegetables have been seen to improve GI motility and overall health. Placement of an intravenous catheter in the cephalic, lateral saphenous, or caudal auricular vein or an intraosseous catheter in the proximal femur or tibia permits hydration to be corrected. Subcutaneous fluids can also be administered. Anorectic rabbits should be force-fed up to four times daily with as much high-fiber food as they will willingly take. A 5-French or 8-French nasogastric feeding tube can be placed in the rabbit in a manner similar to that used in the cat. Alternately, a gastrostomy tube can be placed with endoscope guidance, using a similar technique as in cats. An Elizabethan collar may be required to maintain integrity of either type of indwelling tube. Equine enteral products (Nutriprime; KenVet, Ashland, OH) can be administered through nasogastric tubes, or blenderized regular diets can be administered through gastrostomy tubes for higher fiber content.

Feeding fresh pineapple juice (approximately 10 mL per day), which contains the enzyme bromelain, or papaya tablets that contain papaíne, or proteolytic enzymes (eg, Viokase-V; Fort Dodge Laboratories, Fort Dodge, IA) has reportedly aided the breakdown and passage of trichobezoars, although the value of these products is questionable. There is no evidence that these products can degrade hair. It is possible that they may aid in the breakdown of trichobezoars by dissolving the proteinaceous matrix that binds them together.

If the rabbit has gastric tympany that cannot be medically relieved, or appears obstructed, or the rabbit has been completely anorectic for more than 72 hours, surgical exploration and potential gastrotomy should be considered. Aggressive supportive therapy before and after surgery is recommended to optimize the chances of a successful outcome.

Bacterial Enteropathies

Diarrhea in pet rabbits is commonly caused by bacterial imbalances in the small and large intestine and cecum. Constipation can also be seen with diarrheal disease, for example, in young rabbits because of formation of plugs of mucous diarrhea (“mucoid enteritis”). Bacterial imbalances can result from diets too low in fiber and too high in protein (therefore increasing cecal pH and encouraging dysbiosis), antibiotic usage, or weaning stress. Antibiotics reported to cause fatal diarrhea in rabbits include clindamycin, lincomycin, erythromycin, amoxicillin (with or without clavulanic acid), ampicillin, cephalosporins, and oral penicillin, although it is important to realize that individual rabbits may also respond adversely to “safe” antibiotics such as the quinolones and tetracyclines. A diet containing close to 20% fiber seems to maintain an optimum cecal pH to prevent changes in the normal microbial flora. Treatment of dysbiosis is largely supportive and includes fluid therapy, nutritional support with high-fiber slurries, and bacterial support via transfaunation of fresh cecotropes from a healthy rabbit. Some practitioners also administer pancreatic enzyme supplements. Metronidazole (20 mg/kg given orally every 12 hours) can also be given to combat clostridial overgrowth, but selective overgrowth may still occur.

Although it is unclear how orally adminis-
tered live bacterial cultures (in the form of probiotic supplements or active-culture yogurt) can survive rabbits' gastric pH, it is likely that diseased rabbits have higher gastric pH, and therefore, more bacteria will survive to recolonize the cecum. Once a more benign bacterial population exists in the cecum, perhaps then \textit{Bacteroides} sp. and other normal cecal inhabitants can proliferate. One study stated that live \textit{Lactobacillus} culture may prevent enterotoxemia by decreasing the numbers of \textit{Escherichia coli} in the digestive tract. There is at least anecdotal evidence to suggest that active-culture yogurt is a useful adjunct to treatment of rabbit dysbiosis.

\textbf{Gastrointestinal Parasitism}

Coccidial infections, which can also cause diarrhea, are the most common intestinal parasitic problem in rabbits. Intestinal coccidiosis, caused by \textit{Eimeria} species, can be diagnosed by finding oocysts in a fecal sample. Intestinal coccidiosis is a greater risk to young rabbits because of the accompanying acute dehydration, but can also cause severe illness in older rabbits as a result of intestinal mucosal damage and resultant sepsis. Treatment includes aggressive fluid therapy to counteract the dehydration. Trimethoprim-sulfadiazine (30 mg/kg given orally every 12 hours for 7 to 10 days) or sulfadimethoxine (50 mg/kg given orally once and then 25 mg/kg given orally daily for 3 weeks) may be used. Rabbits that survive infection generally are immune to future infections.

A hepatic form of coccidiosis caused by \textit{Eimeria stiedae} also occurs in rabbits. Clinical signs may include anorexia, weight loss, hepatomegaly, and diarrhea. Antemortem diagnosis and treatment are similar to that for the intestinal form. With the hepatic form, however, abdominal enlargement and hepatomegaly may be present. Abdominal radiographs and ultrasonography may be used to confirm hepatomegaly. Because infective oocysts are passed in feces, the rabbit's cage, food bowl, and water bottle should be routinely disinfected.

Other intestinal parasites are less of a problem in rabbits than in many other domestic species. The most common helminth parasite seen in the rabbit is the pinworm \textit{Passalurus ambiguus}. A diagnosis is made by finding pinworm ova in the feces. Rabbit pinworms do not deposit eggs around the anus, so the transparent tape technique used to diagnose canine oxyuriasis is not applicable. \textit{Passalurus} has a direct life cycle and is nonpathogenic in rabbits. However, if treatment is elected, this may include ivermectin (0.2 to 0.4 mg/kg given subcutaneously), fenbendazole (20 mg/kg given orally once daily for 5 days), thiabendazole (50 mg/kg in two treatments 3 weeks apart), or piperazine (200 to 500 mg/kg/day given orally for 2 days).

Rabbits can also serve as intermediate hosts for the canine tapeworm \textit{Taenia pisiformis}. Transmission occurs through the contamination of water, feed, or bedding with canine feces. Clinical signs may include lethargy, abdominal distention, and weight loss. Treatment is usually not required. However, rabbits passing proglottid segments or ova in their stools can be treated with praziquantel (5 to 10 mg/kg given orally, subcutaneously, or intramuscularly once, and then repeated in 10 to 14 days). Canine fecal contamination should be avoided in rabbit areas.

Rabbits harbor a nonpathogenic intestinal yeast \textit{Saccharomycopsis gutulatus}, which may be mistaken for coccidia or bacilli. This yeast does not require treatment.

\textbf{References}

9. Remeeus PGK, Verbeek M: The use of calcium hydroxide in the treatment of abscesses in the cheek of the rabbit


20. LaMont JE, Sonnenblick EB, Rothman S: Role of clostridial toxin in the pathogenesis of clindamycin colitis in rabbits. Gastroenterology 76:356-361, 1979


