Diagnosis of dental problems in pet rabbits (*Oryctolagus cuniculus)*

Diagnose van tandproblemen bij gezelschapskonijnen (Oryctolagus cuniculus)

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ABSTRACT

Dental problems are very common in pet rabbits. To establish a correct diagnosis of rabbit dental pathology, a general knowledge of normal dental anatomy and physiology is necessary. The specific anatomy and the most common pathologies of rabbit dentition are reviewed.

Techniques for diagnosing dental abnormalities − such as clinical examination, radiography and computed tomography (CT) − are summarized. Finally, two clinical cases of rabbits with dental pathologies are described.

SAMENVATTING

Tandafwijkingen zijn frequent voorkomende aandoeningen bij gezelschapskonijnen. Om een nauwkeurige diagnose van tandpathologieën te stellen, is een goede kennis van de normale anatomie en fysiologie van het konijnengebit een noodzaak.

In dit artikel wordt een overzicht van de literatuur gegeven over de specifieke gebitsanatomie en de meest voorkomende tandafwijkingen bij het konijn. De verschillende technieken voor het diagnosticeren van tandpathologieën worden besproken, zoals het klinisch, het radiografisch en het computertomografisch (CT) onderzoek. Vervolgens worden twee klinische gevallen van konijnen met gebitsafwijkingen beschreven.

INTRODUCTION

As rabbits are increasingly being kept as pets, it is important for the veterinary practitioner to be aware of the specific health problems of these animals. Due to the continuous growth and eruption of their teeth, rabbits are very susceptible to dental abnormalities (Crossley, 2003; van Foreest, 1998; Verhaert, 2004). Any congenital (e.g. mandibular prognathism) or acquired abnormality in shape, position or structure of the teeth interferes with normal wear (Capello, 2005; Harcourt-Brown, 1997a; Harcourt-Brown and Baker, 2001; Harcourt-Brown, 2004; Lobprise and Wiggs, 1991; Meredith, 2006). Inappropriate husbandry and diet are associated with several acquired dental problems in domestic rabbits. In pet rabbits that receive husbandry and a diet similar to that of wild rabbits, the incidence of dental pathology is low (Meredith and Crossly, 2002).

The most common dental problems are cheek teeth overgrowth, incisor overgrowth, facial abscesses, periodontal disease, and nasolacrimal duct pathology (Capello, 2005; Lobprise and Wiggs, 1991; Verhaert, 2004; Verstraete and Osofsky, 2005). These dental pathologies are often very difficult to diagnose. In addition to a thorough history and intra-oral inspection, a radiographic or CT examination of the head may be necessary to identify the extra-oral deformations of the teeth and jaw bones (Meredith, 2006; Verhaert, 2004; Verstraete and Osofsky, 2005).

These findings, in particular, determine the choice of a favorable treatment and the long-term prognosis. Therapeutic options include dietary changes (Crossley, 2003; Meredith, 2006), occlusal adjustment of involved teeth, extraction of teeth severely affected by endodontic or periodontal disease (Lobprise and Wiggs, 1991), and abscess debridement (Verstraete and Osofsky, 2005). Untreated animals show anorexia, weight loss, have grooming difficulties and become debilitated (Harcourt-Brown and Baker, 2001; Meredith, 2006; Verhaert, 2004; Verstraete and Osofsky, 2005). Furthermore, they may develop secondary pathologies prone to opportunistic infections, such as facial abscesses and nasolacrimal duct infections (Crossley, 2003).

This article provides a short review of the dental anatomy, pathology, and clinical, radiographic and CT examination of rabbit dentition. Two clinical cases of rabbits with dental pathologies are described.

NORMAL DENTAL ANATOMY

Rabbit dentition is heterodont and is composed of 28 teeth. In the upper jaw, two incisors (*dens incisivus major* and *dens incisivus minor*) and six cheek teeth (three premolars and three molars) are visible per quadrant. In the lower jaw, one large incisor and five cheek teeth (two premolars and three molars) are

present on both sides (Michaeli *et al.*, 1980). Consequently, the dental formula of the rabbit is:

2I 0C 3P 3M
1I 0C 2P 3M

All teeth are aradicular hypsodont, which means that there is an anatomic long crown but no true root. The crown is divided into supra-gingival and sub-gingival parts. The latter part is also called the reserve crown (Wiggs and Lobprise, 1997; Crossley, 2003; Verhaert, 2004; Capello and Gracis, 2005; Meredith, 2006).

In the upper jaw, 2 rows of incisors are present: on the palatal side of the large incisors, a second row of little peg teeth is visible. At rest, the incisors are in occlusion (i.e. the mandibular incisors are positioned between the first and second rows of maxillary incisors).

The incisors have a thick layer of enamel on the labial side and almost none on the lingual/palatal side. Therefore, the lingual/palatal side wears faster than the labial side, so that the pattern of wear for the incisors is chisel-shaped. In contrast to rodents, rabbit enamel is not pigmented (van Foreest, 1998; Bongaerts, 2003; Crossley, 2003; Verhaert, 2004; Capello, 2005; Verstraete and Osofsky, 2005).

Incisors and premolars are separated by a large diastema. There is no anatomical difference between premolar and molar teeth, which act as a single functional unit. For this reason, premolars and molars are commonly referred to as "cheek teeth" (Capello, 2005; O'Malley, 2005). In the normal rabbit, the eruption and growth of the incisors continues at a rate of 2-3 mm a week (Westerhof and Lumeij, 1987; Lobprise and Wiggs, 1991; van Foreest, 1998; Verstraete; 2003; Verhaert, 2004).The incisor growth and wear are balanced (van Foreest, 1998; Verstraete and Osofsky, 2005; Meredith, 2006). Therefore the diet must contain abrasive particles to ensure this equilibrium between growth and wear (Harcourt-Brown, 1995; 1996). Mandibular incisors and cheek teeth grow and erupt faster than maxillary teeth (Meredith, 2006).

The dentition is anisognothic, with the maxilla being wider than the mandible, so the cheek teeth of the lower and upper jaws have only a partial overlap. The normal occlusal plane of cheek teeth in rabbits is 10%, but a wide latero-lateral movement of the jaws results in a normal abrasion (Capello and Gracis, 2005; Verstraete and Osofsky, 2005).

DENTAL PHYSIOLOGY: HUSBANDRY AND DIET

Aradicular hypsodont teeth grow continuously, but physiological wear while eating compensates for this. Insufficient wear from 'soft' (i.e. insufficiently abrasive) food, however, leads to crown elongation and abnormal forces at the occlusal plane. This hinders eruption and may subsequently lead to secondary destruction of alveolar bone and 'apical growth' of the teeth (Verhaert, 2004). Many authors consider insufficiently abrasive food to be the main cause of rabbit dental pathology (Crossley, 2004; Harcourt-Brown, 1995; 1996; 1997a; Oglesbee, 2006; Verhaert, 2004).

The ideal diet consists of grass and coarse hay, occasionally supplemented with dry pellets (maximum 10% of the total diet) and fresh vegetables. This kind of abrasive diet prevents tooth overgrowth and is also beneficial to the gastrointestinal system (Oglesbee, 2006).

Harcourt-Brown (1996, 1997a, 1997b) showed that many rabbits are low in blood calcium (Ca) and are therefore prone to osteoporosis and poor dental quality. According to some authors (Kamphues, 1991; Harcourt-Brown, 1995; 1996; 1997a; 1997b), daylight and dietary improvement (such as a daily vitamin/mineral supplement) can improve bone and tooth quality in cases of deficiencies. However, opinions vary regarding the significance of dietary Ca levels for dental disease. Meredith and Crossley (2002) found that, once formed, the cheek teeth are protected from resorption by systemic calcium homeostasis. Furthermore, tooth formation is little affected by dietary Ca levels, and a prolonged period of extreme deficiency is required before tooth growth and development are significantly affected (Crossley, 2001; Meredith and Crossley, 2002). However, insufficient dietary intake of calcium does appear to enhance the progression of dental resorptive lesions. On the other hand, providing excessive quantities of Ca can induce the formation of uroliths (Harcourt-Brown, 1996).

Harcourt-Brown (1997a, 1997b) also stated that the major cause of malocclusion is nutritional osteodystrophy, due to an imbalance of Ca, vitamin D and/or phosphorus (P). Although vitamin D is not required for intestinal absorption of Ca in diets with an adequate Ca concentration, it may be required for active intestinal Ca absorption in diets where Ca concentration is deficient (Harcourt-Brown and Baker, 2001). Kennedy (1965) and Brommage *et al.* (1988) stated that vitamin D helps to maintain Ca homeostasis through its effects on renal excretion of Ca and P. As a consequence, vitamin D deficiency may exacerbate Ca deficiency.

EXAMINATION OF THE DENTITION

Clinical examination

The incisors alone cannot be relied upon as an indicator of dental health. External palpation of the mandibles and maxillae should be part of the routine clinical examination. Abnormalities may suggest dental problems (Harcourt-Brown, 1995). In conscious rabbits, an otoscope can aid inspection of the oral cavity: wounds of the tongue and buccal mucosae can be visualised, and overgrowth of cheek teeth can be detected. In order too achieve a thorough view and to diagnose less severe lesions, anesthesia is necessary (Harcourt-Brown, 1995). Cheek dilators can be used during the examination of the oral cavity, but mouth

gags must be used with caution as they can damage the teeth and the temporomandibular joint (Verhaert, 2004). Endoscopy may greatly aid the detection of subtle lesions caused by malocclusion (Capello, 2005).

At rest, the incisors are held in occlusion, which means that the tips of the mandibular incisors are resting between the first and second rows of the maxillary incisors. The wear pattern must be chisel-shaped when the occlusal plane is horizontal (Verhaert, 2004).

Depending on the size of the rabbit, the mandibular cheek teeth show a very short crown, while the maxillary cheek teeth are worn to the level of the gingiva. The occlusal plane of the cheek teeth has an angle of 10 degrees (Verstraete and Osofsky, 2005).

Anesthesia

As some diagnostic examinations (such as CT and radiography of the rabbit skull) require anesthesia, we provide a short overview of the most frequently used methods.

Since rabbits are unable to vomit, fasting before anesthesia is not necessary.

Pre-medication is strongly advised, as the use of sedatives decreases the anesthetic and recovery times and reduces anxiety (Meredith and Crossley, 2002; Vancraeynest, 2002; Heard, 2004; Meredith, 2006). Multiple premedicants or combinations are mentioned in the literature. Meredith and Crossley (2002) stated that fentanyl/fluanisone, medetomidine, xylazine, acepromazine, diazepam and midazolam are suitable products.

Induction and maintenance of general anesthesia can be performed by inhalation or by injection (or by a combination of these two methods). Most authors prefer inhalation anesthesia, with isoflurane administered via mask or tracheal tube. Whenever an inhalant is used for induction, pre-medication is necessary to prevent the initial excitement phase, which may result in injury (such as fracture of the lumbal vertebrae) due to kicking with the hind limbs (Heard, 2004; Keeble and Meredith, 2006). Pre-medication also diminishes the reaction to the smell of the volatile agent, which incites the rabbit to initially hold its breath and then to breathe very deeply. This can result in the inhalation of a high dose of anesthetic product, which may be dangerous (Flecknell, 2000; Vancraeynest *et al.*, 2002; Heard, 2004).

Half-open systems, such as the Bain coaxial system or the Ayre's T-Piece, are the most suitable anesthetic systems used in rabbits (Flecknell,1996; Vancraeynest *et al.*, 2002; Keeble and Meredith, 2006).

Radiographic examination

Radiographs give valuable information about the type and extent of pathology. This is important to achieve an accurate diagnosis, which is necessary for appropriate treatment.

Still, despite the radiographic examination, a lot of abnormalities may be missed. Even an experienced examiner will discover only 85% of the pathology that is present (Crossley, 2000).

For the radiographic evaluation of rabbit dentition, three basic skull views are required: namely, a latero-lateral (Figure 1), a dorsoventral (Figure 2) and a rostrocaudal (Figure 3) view. In some cases, additional

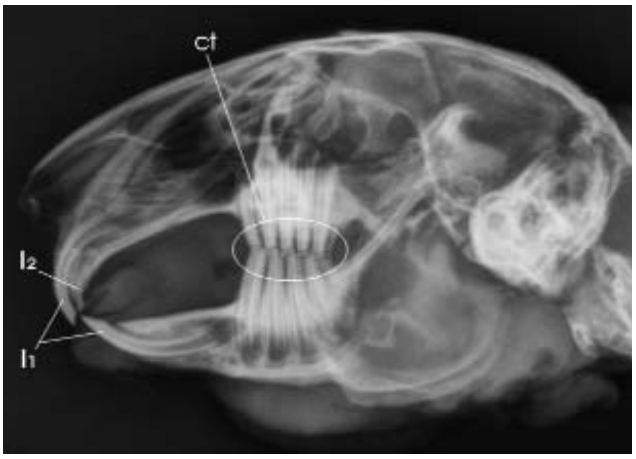

Figure 1. Normal laterolateral radiographic view of the rabbit skull. Note the maxillary incisors (I1, I2), the mandibular incisors (I1) and the maxillary and mandibular cheek teeth (ct).

Figure 2. Normal dorsoventral radiographic view of the rabbit skull. Note the incisors (I1, I2) and the maxillary and mandibular cheek teeth (ct).

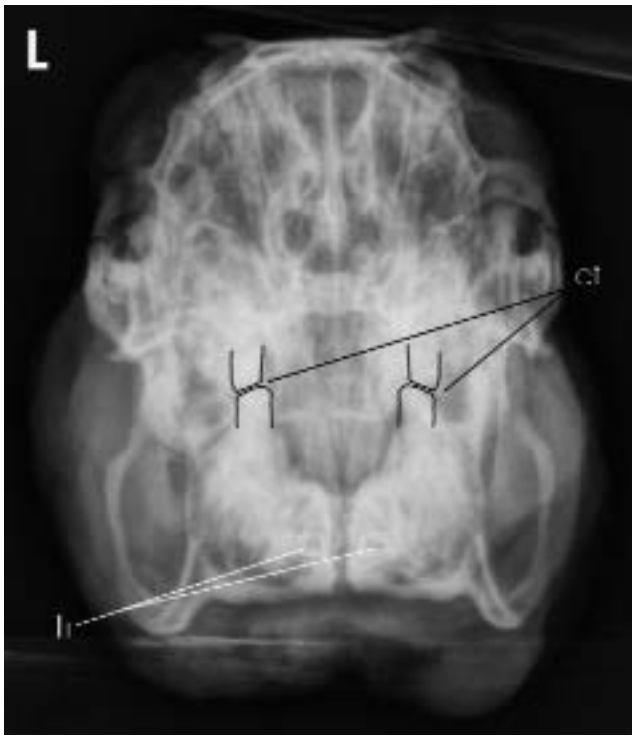

Figure 3. Normal rostrocaudal radiographic view of the rabbit skull. Note the mandibular incisors (I1) and the maxillary and mandibular cheek teeth (ct).

Figure 4. Normal transverse CT-image of the rabbit skull. Note the maxillary and mandibular cheek teeth (ct).

oblique and intra-oral views are mandatory. As standard radiographic values, 5-15mAs, 40-100 kV and 50cm film-focus distance (FFD) are proposed (Crossley, 2000; Verhaert, 2004; Silverman and Tell, 2005). However, 4mAs, 57KV and 100cm FFD are used in the Clinic of Medical Imaging of the Faculty of Veterinary Medicine, Ghent University. For rostrocaudal views, anesthesia and higher exposures are necessary (in our clinic, we use 68kV). Short exposure times (i.e. 0.017 sec and faster) should be used to minimize patient motion artefacts (Silverman and Tell, 2005).

A systematic method of evaluating radiographs can help to prevent under-diagnosing pathology. The laterolateral view gives the most important information about the dental situation in rabbits (Harcourt-Brown, 1997a; Harcourt-Brown, 1999; Crossley, 2004; Verhaert, 2004). The incisors have a chisel-shaped pattern and are in occlusion at rest, while the cheek teeth are out of occlusion. Although rarely seen in pet rabbits, rostral convergence of the palatine shelf and the dorsal border of the mandible is normal. The ventral mandibular border is smooth, while the normal germinal tissue shows radiolucencies. The palatine shelf is smooth, without bony deformation or perforation by the apices of the maxillary incisors. The laterolateral view is very useful for examining abnormalities such as deformations of the occlusal plane of the cheek teeth, abnormal wear pattern of the incisor teeth, and elongation and curving of the roots of the cheek teeth and incisors (Capello, 2005). Also, deformation and even perforation of the mandibular cortex stand out visibly. In severe cases, abscesses may be seen as radiolucent areas surrounded by periostal reaction.

On the dorsoventral view, the bony contours and the orbits are sharply delineated, only the lacrimal processes are protruding. Compared to the laterolateral view, the dorsoventral view does not provide extra information about rabbit dentition (Verhaert, 2004), except for severe cases, when the roots of the cheek teeth are elongated and may perforate the orbita or mandible. Although interpretation can be difficult due to superimposition of many bone and dental structures, the occlusal plane of the cheek teeth can be evaluated on the rostrocaudal view (Capello, 2005). In healthy rabbits, this plane must be almost horizontal (10 degree angle) with absence of spiking or tipping (Verhaert, 2004). Severe spikes on the labial side of the maxillary cheek teeth and on the lingual side of the mandibular cheek teeth can also be seen on this view.

CT examination

CT is the most valuable diagnostic imaging technique for detecting early tooth abnormalities. Compared to conventional radiography, CT has greater sensitivity to detect subtle bony changes and provides more soft tissue detail as well (Brenner *et al.*, 2005; Capello, 2005) (Figure 4) .

In chinchillas, many dental pathologies are missed on radiographs (Crossley, 2000; Verhaert 2004), whereas CT scans give more information, especially in cases of early cheek tooth pathology (Crossley *et al.*, 1998). However, a similar study in rabbits (Verstraete *et al.*, 2005) showed no advantages of CT

over X-rays; both methods provided comparable diagnostic information (Verstraete and Osofsky, 2005).

DENTAL PATHOLOGIES

General clinical symptoms

Due to the progression of dental abnormalities, general clinical symptoms may become visible. In most cases, these symptoms are non-specific and may vary from anorexia and weight loss to poorly maintained fur and decreased grooming (Capello, 2005) to decreased or absent faecal output. Excessive salivation is also a frequently observed symptom. Depending on the affected teeth, ocular and nasal discharge can occur (Kennedy, 1965; Crossley, 1997; Legendre, 2002).

Gastrointestinal stasis commonly accompanies dental disease. Cecocolonic hypomotility can result in an alteration of the enteric microflora. In addition, rabbits with dental problems prefer diets that are low in fiber (and typically high in carbohydrates, which provide a source of fermentable products). This facilitates the growth of pathogens such as *Escherichia coli* and *Clostridium* species. Bacterial dysbiosis can cause acute diarrhoea, enterotoxemia, ileus and chronic intermittent diarrhoea. In some cases of advanced or severe disease, the prognosis is so poor that euthanasia becomes a humane option (Capello, 2005; Verstraete 2005b; Oglesbee, 2006).

Incisor overgrowth

Primary incisor overgrowth is seen in young rabbits, usually within the first year, with a predisposition in dwarf rabbits. This pathology is caused by an inherited skeletal malocclusion, namely relative mandibular prognathism, which is due to maxillary brachygnathism (Fox and Crary, 1971; Böhmer and Köstlin, 1988; Lobprise and Wiggs, 1991; Harcourt-Brown, 1997a; van Foreest, 1998; Legendre, 2002; Verstraete, 2003; Verhaert, 2004; Capello, 2005; Verstraete and Osofsky, 2005; Oglesbee, 2006). When the mandible is too long compared to the maxilla, normal incisor occlusion is not possible. The mandibular incisors are located either at the same level as, or on the labial side of, the large maxillary incisors. In these cases, incisor wear is abnormal, resulting in crown elongation. The maxillary incisors may flare out laterally or curl inward into the oral cavity, while the mandibular incisors protrude from the mouth (Fox and Crary, 1971; Lobprise and Wiggs, 1991; Verhaert, 2004; Verstraete and Osofsky, 2005).

When the eruption of incisors is hindered by abnormal occlusal forces, the teeth will grow in an apical direction. In the maxilla, this may eventually result in perforation of the palatine shelf. Rabbits with untreated primary incisor overgrowth will develop secondary cheek teeth overgrowth. Primary incisor overgrowth is in fact over-diagnosed, as cheek teeth overgrowth causes secondary incisor overgrowth. In cases without extensive cheek teeth overgrowth, the prognosis after treatment is quite good. The abnormal position, wearing pattern and length of the incisor teeth may be clearly visible on the laterolateral radiographic views (Verhaert, 2004). Even more details can be seen on the computer tomographic views.

Cheek teeth overgrowth

Cheek teeth overgrowth is a very common pathology in older pet rabbits. However, a lot of rabbits are presented only when obvious secondary incisor overgrowth is noticed (Verhaert, 2004). In the early stage of the disease, the diagnosis of cheek teeth overgrowth can easily be missed. Animals must be sedated and a total mouth inspection must be performed. Spikes are seen on the buccal side of the maxillary cheek teeth, and on the lingual side of the mandibular cheek teeth, and may cause wounds of the cheek mucosa and tongue, respectively (Crossley and Meredith, 2002; Legendre, 2002; Crossley, 2003; Verhaert, 2004; Capello, 2005; Verstraete and Osofsky, 2005). Late-stage disease is clearly visible, even in conscious animals. In severe cases, perforation of the alveolar bone, or complications such as abscess formation in one or more teeth, may be present.

On the laterolateral radiographic view, it is possible to verify the position, length and periapical region of the incisors. In addition to occlusion of the cheek teeth (which can vary from a straight line to extremely zigzag delineation), curving, resorption of roots, or extensive periapical lucencies are also visible. On the same view, the ventral border of the mandible can be examined for thinning or even perforation (Verhaert, 2004). According to Capello (2005), cheek teeth overgrowth can be easily diagnosed by the abnormal curving of the apices and the possible alveolar bone perforation by the roots.

On CT views, more detailed information and a more precise extension of the lesions is achieved.

Facial abscess

Facial and jaw abscesses may have several causes, such as endodontic or haematogenous infection or a penetrating foreign body (Crossley, 2003). In some cases, the abscesses are caused by external wounds (Crossley and Meredith, 2002; Crossley, 2004; Verhaert, 2004; Meredith, 2006).

In pet rabbits, however, the frequently seen abscesses of the face and jaw are usually due to dental problems. This is caused either by mucosal perforation by dental spikes (Harcourt-Brown, 1997a; Verhaert, 2004; Capello, 2005) or by penetration of the bone by apical growth of the teeth involved. According to Harcourt-Brown (1997b), retrobulbar abscesses are associated with penetration of the alveolar bulla, maxillary abscesses can be associated with perforation of the lacrimal bone, and mandibular abscesses are associated with penetration of the mandible.

Clinically, enlargement of the jaws becomes

visible. In the case of a retrobulbar abscess, protrusion of the eyeball can be noticed. Usually, only the cheek teeth are affected. Sometimes the incisors can be involved, as clipping overgrown incisor teeth with a nail cutter can result in a longitudinal, sub-gingival fracture with pulp exposure (Verhaert, 2004). To diagnose tooth involvement in the facial abscess, and to determine the exact localization and extension of the process, radiography is necessary.

When abscesses are present, they may be seen on radiographs as radio-lucencies around the tooth (teeth), surrounded by periostal reaction and soft tissue swelling.

On CT views, similar signs are visible, but the extension of the lesion becomes more obvious. It is also possible to detect the lesions in an earlier stage.

Periodontal disease

Plaque-induced inflammation of the periodontium is rare in rabbits, although this pathology is possibly under-diagnosed (Verhaert, 2004). In rabbits fed a normal abrasive diet, the exposed crowns are short and, as a consequence, the teeth surfaces for plaque accumulation are very small (Crossley, 2003; 2004). In cases with reduced tooth wear, the risk of caries and periodontal disease increases. Severe periodontal destruction may impact the endodontic system, which can result in the development of periodontal abscesses (Crossley, 2002; Verhaert, 2004).

Certain foods may trigger destruction of the periodontium. Crossley (2003) stated that the most common primary cause of periodontal disease is the impact of sharp pieces of material on the periodontium. However, more frequently, periodontal disease develops secondary to the reduced or arrested eruption of teeth.

Less common dental pathologies

In two publications the presence of root resorption and caries in rabbits is mentioned. Caries is a bacterial plaque-associated disease and is absent in animals that are fed a natural diet (Crossley and Meredith, 2002; Crossley, 2003; 2004).

Trauma may result in the fracture of one or more teeth or may cause luxation or fracture of the jaw (Lobprise and Wiggs, 1991; Crossley and Meredith, 2002; Crossley, 2003).

Pathologies of the nasolacrimal duct

The nasolacrimal duct extends from the orbit to the nasal fossa, and runs close to the roots of the cheek teeth and upper incisors (Marini *et al.*, 1996; Harcourt-Brown 1997a; Oglesbee, 2006). The roots of the upper incisors lie close to a U-bend in the nasolacrimal duct. In the early stages of dental disease, this is most likely to be the site where the duct becomes obstructed. When this happens, the long roots of the incisors are often deviated, curling inward and possibly penetrating the nasal passage (Harcourt-Brown 1997a). Hence, dacryocystitis is one of the early signs of dental disease.

Tooth root abscesses may impinge the nasolacrimal duct, which can also result in blockage or dacryocystitis of the duct (Harcourt-Brown 1997a; Capello 2005; Oglesbee 2006). Crossley (1995) stated that premolar abscessation may occasionally cause lacrimal duct obstruction, whereas root elongation of the cheek teeth rarely does.

In the later stages of dental disease, periosteal reaction around the site of penetration takes place either in the nasal passages or in the lacrimal bone. This reaction may result in rhinoliths, palpable abscesses of the lacrimal bone or mucopurulent nasal discharge (Harcourt-Brown 1997a; Capello 2005).

On laterolateral radiographic views, elongated roots of the maxillary cheek teeth are visible at the location of the nasolacrimal duct. To visualize the nasolacrimal duct, contrast radiography may be performed (Capello, 2005).

CONCLUSION

A good knowledge of normal dental anatomy, as well as husbandry and dental pathology, is necessary to recognize dental problems in rabbits.

An accurate history must be followed by a thorough clinical examination. Radiography or CT examination is often necessary to identify the problem and the extension of the lesion, so that the prognosis and possible treatment can be determined.

An abrasive diet, which enables normal dental wear and thus prevents dental pathologies, has proven to be of great importance in animals with an aradical hypsodont dentition.

CLINICAL CASES

Severe incisor and cheek teeth overgrowth

A female 4-year-old rabbit was presented at the Clinic of Medical Imaging, Faculty of Veterinary Medicine, Ghent University, with a history of anorexia lasting for 3 weeks. Clinical examination of the heart, lungs and abdomen revealed no abnormalities. As dental problems are an important cause of anorexia, radiographic examination of the skull was performed, which included laterolateral (Figure 5), dorsoventral (Figure 6) and rostrocaudal radiographic views[a,b]. Technical settings of the radiographic unit[c] were 57 kV and 4mAs. For the rostrocaudal views, general anesthesia using a mask (Isoflurane[d]: 5% induction; 2% maintenance) was required. On the laterolateral view, it was possible to see that the incisors were out of occlusion. The left maxillary incisor was elongated and curled into the oral cavity, whereas the right one was shorter. Root elongation of the maxillary incisors with thinning of the os palatinum was clearly visible on the laterolateral view, as was root elongation of the mandibular incisors. Also on the laterolateral view, the

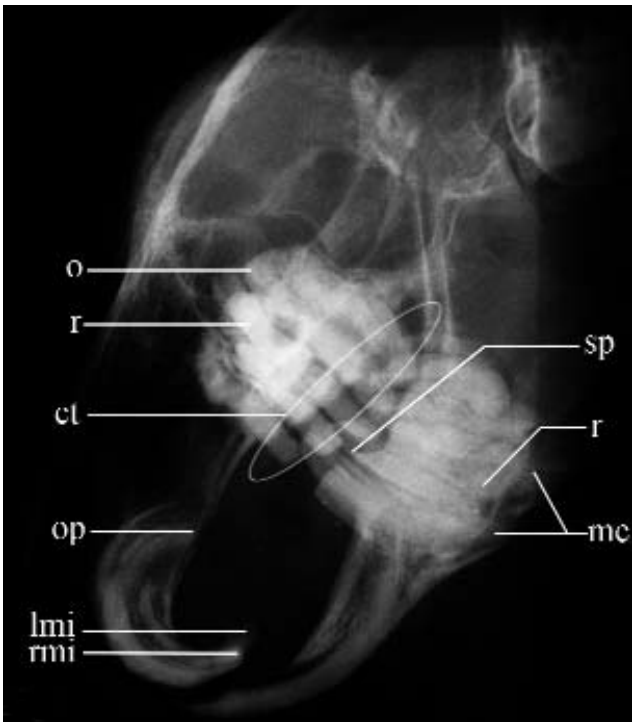

Figure 5. Laterolateral radiographic view of the rabbit skull. The elongated left maxillary incisor (lmi) is curled into the mouth, the right maxillary incisor (rmi) is shorter. Note the thinning of the os palatinum (op) by the elongated roots of the maxillary incisors. An abnormal wearing pattern of the cheek teeth (ct) is present and spikes (sp) are visible. Note the elongated roots (r) of the maxillary and mandibular cheek teeth with perforation of the orbita (o) and the mandibular cortex (mc).

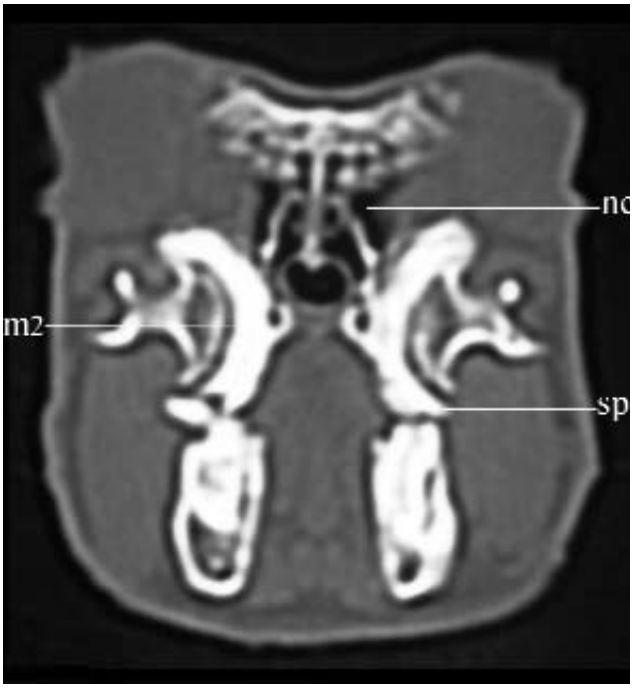

Figure 7. Transverse CT image of the rabbit skull. Root elongation and an abnormal direction at the level of the maxillary cheek teeth M2 (m2) are present. There are spikes (sp) on the labial side of the maxillary cheek teeth. Nasal cavity = nc.

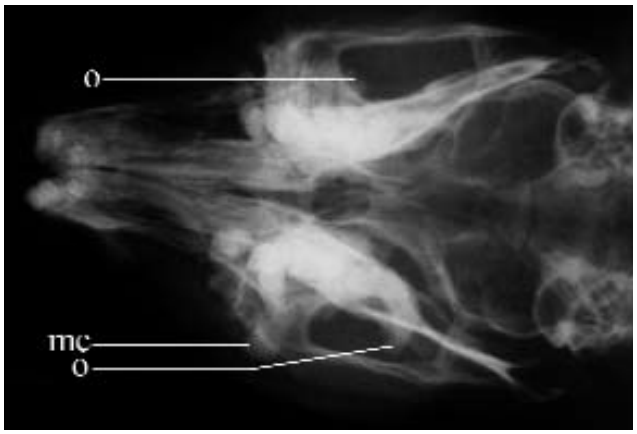

Figure 6. Dorsoventral radiographic view of the rabbit skull. Note the elongated roots of the maxillary and mandibular cheek teeth with perforation of the orbita (o) and the mandibular cortex (mc).

cheek teeth showed an abnormal, very irregular wearing pattern and multiple spikes. Unsharp and irregular delineation of the roots of all cheek teeth was seen. All views showed root elongation of the maxillary cheek teeth with prominent secondary perforation of the orbita and probably of the nasal cavity. A bony proliferation was noticed at the maxillary root apices. As a result of root elongation of the mandibular cheek teeth, bulging and perforation of the mandibular cortex were noticed on the laterolateral and dorsoventral views.

To achieve more detailed information about the pathology, a CT examination of the skull was performed immediately after the radiographic examination. The patient was positioned in ventral recumbency. Using a third generation CT-unit[e], transverse, 3-mm thick CT scans of the skull were obtained at 3-mm intervals. The settings for the CT image technique were 120 kV and 160mA. Individual images were reviewed by the use of a bone window setting (window width: 3814 Hounsfield units; window level: 594 Hounsfield units), formatted on x-film[f], and evaluated.

On the most rostral CT-image, it was possible to notice the shorter right maxillary incisor and the thinning of the os palatinum caused by root elongation.

On the more caudal CT-images, root elongation and abnormal direction of the maxillary cheek teeth were visible, especially at the level of M1, M2 (Figure 7) and M3. The very long, curved root of M3 even perforated the orbita. In contrast to the radiographic findings, perforation of the nasal cavity could be excluded with certainty. Multiple spikes were seen on the labial side of the maxillary cheek teeth (Figure 7). The root elongation of the mandibular cheek teeth, with bulging and perforation of the mandibular cortex, was noticed especially at the level of P2, M1 and M2 (Figure 7).

On the CT- images, the lesions due to root elongation became more visible and were seen to be more severe than they had appeared to be on the x-

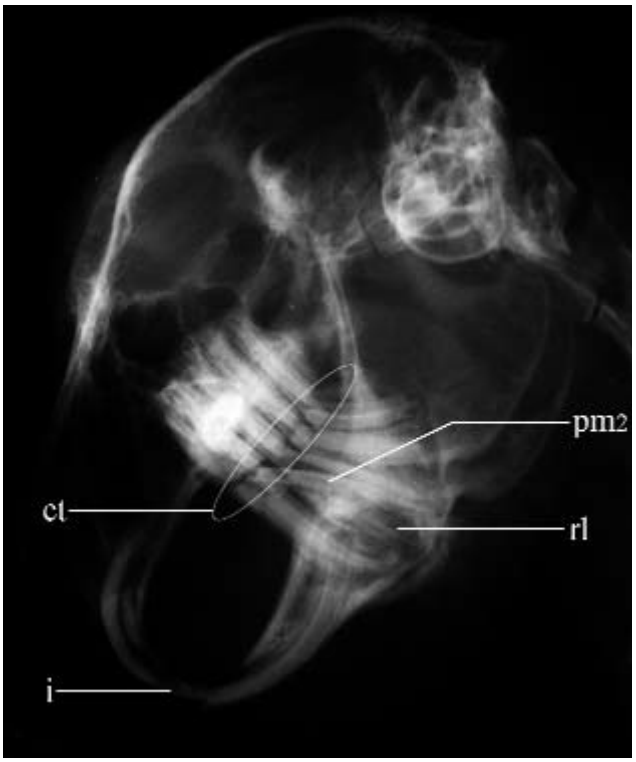

Figure 8. Left lateral radiographic view of the rabbit skull. An abnormal occlusion and wear pattern of the incisors (i) are visible. Note the irregular wear pattern of the cheek teeth (ct) with an abnormal growth direction at the level of mandibular PM 2 (pm2). A radiolucent lesion (rl) delineated by sclerosis can be seen between PM1 and PM2.

rays. It was also possible to determine a more precise localization of elongated or perforating maxillary cheek teeth roots on the CT-images.

Reshaping or extraction of the rabbit's teeth was advised to the owner. However, frightened by the poor prognosis, the owner decided not to treat the animal.

Incisor and cheek teeth overgrowth with abscessation

A 3-year-old male dwarf rabbit was presented at the Clinic of Medical Imaging, Faculty of Veterinary Medicine, Ghent University, with severe soft tissue swelling on the left side of the cranial mandible, at the level of the first and second cheek teeth. According to the owner, the animal had been anorectic for several days. There was no history of abnormal behavior.

Clinical examination was performed and, except for depression and the above-mentioned mandibular swelling, no abnormalities were found. Because of the soft tissue swelling at the mandible, x-rays were advised.

For radiographic examination of the rabbit skull, laterolateral (Figure 8) and dorsoventral (Figure 9) radiographic views[a,b] were made. The settings of the radiographic unit[c] were 57 kV and 4mAs. On both views, very large soft tissue swelling was visible on the left side of the mandible. On the laterolateral view, an edge-to-edge occlusion of the incisors was seen,

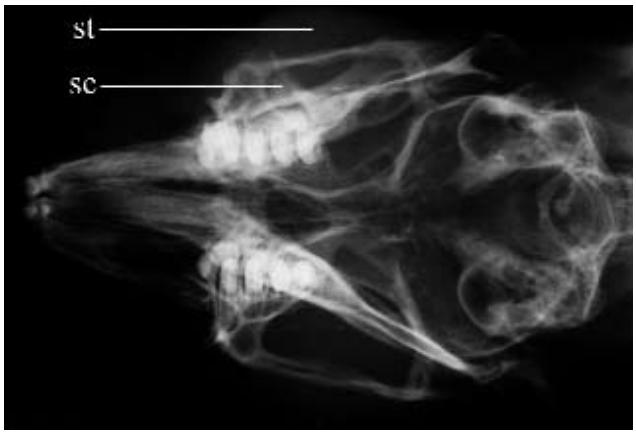

Figure 9. Dorsoventral radiographic view of the rabbit skull. A large soft tissue swelling (st) is present on the left side of the mandible. At this level, sclerosis (sc) is present.

with an abnormal wearing pattern of the maxillary incisors. A mild root elongation of the maxillary incisors was noticed.

The laterolateral view also showed that the cheek teeth were in occlusion, with an irregular wear pattern and multiple spikes. At the site of the maxillary cheek teeth, especially PM1 and PM2, a mild root elongation was noticed. The left mandibular PM2 showed an abnormal growth direction. At the ventral cortex of the mandible, a sharply delineated, radiolucent lesion could be seen between PM1 and PM2.

Based on these findings, the owner requested euthanasia of the rabbit, and no further examinations, such as rostrocaudal radiographic views or CT, were performed.

Post-mortem dissection of the rabbit skull revealed a large abscess filled with pus at the left mandible. The site corresponded with the radiographic signs at the height of the mandibula on the lateral view.

[a] x-ray cassette, Fuji F63, Fuji Medical, Antwerp, Belgium
[b] x-ray film, Fuji 100 NIF /HR-T-30, Fuji Medical, Antwerp, Belgium
[c] Rx –unit, Ralco X-ray equipment Verachtert, Antwerp, Belgium
[d] Isoflurane, Isoba, Shering-Plough Animal Health, Brussels, Belgium
[e] CT-scanner Pace Plus, GE Medical Systems, Milwaukee, USA
[f] x-ray film, Fuji FM-DP 2636, Fuji Medical Antwerp, Belgium

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