COMMISSIONED PAPER

Rabbit dentistry

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SUMMARY

Dental disease is one of the most common reasons for presentation of a rabbit to the veterinary surgeon, although this fact may not be immediately apparent. Anorexia, weight loss, facial swelling, ocular discharge, lack of grooming, accumulation of caecotrophs and fly strike should all alert the practitioner to the possibility of dental disease, and a full dental examination should be carried out. Even in rabbits with no apparent clinical signs, assessment of the teeth should always be an essential part of the clinical examination, as early detection and treatment of disease is more likely to have a good outcome. Unfortunately, many rabbits are presented with later stages of disease, where cure is not possible and palliative treatment is all that is achievable. The majority of cases of dental disease are preventable by the feeding of a natural high fibre diet, and thus owner education is vital.

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Dental Anatomy and Physiology

The dental formula of the rabbit is: 2 x (I 2 / 1 C 0 / 0 P 3 / 2 M 3 / 3). Rabbits do have a deciduous dentition, but this is of no clinical significance as it is shed within the first few days after birth.

Rabbits have six unpigmented incisor teeth. There are four maxillary incisors, two labially, which have a single vertical groove in the midline, and two rudimentary "peg teeth" located palatally. There is a large diastema between the incisor and premolar teeth. The premolar teeth are similar in form to the molar teeth, and are usually described together as the 'cheek teeth'. They are closely apposed and form a single functional occlusal grinding surface. The premolars and molars have a groove on the buccal surface formed by infolding of enamel. Slower wear of the enamel at the circumference of the teeth and the infolding compared to the softer dentine creates ridges, which are matched by depressions in the opposite tooth, and increase grinding efficiency. It should be noted that normal rabbits frequently have a small vertical ridge along the lingual surface of the cheek teeth – this should not be confused for abnormal "spikes" which are always lateral (see below).

All teeth erupt continuously and do not have a true anatomical roots (aradicular (= without a root) hypsodont (=high crowned)). Roots are more correctly described as "reserve crowns", thus much of the crown is subgingival. Some refer to the visible oral portion as the clinical crown. Because of the continued eruption of rabbit teeth, the periodontal ligament has finer collagen fibrils and is relatively weak.

The first incisor teeth have a chisel-like occlusal surface (Fig 1). The thicker layer of labial enamel means that the lingual side wears more quickly, forming the chisel shape of the cutting surface. At rest the tips of the mandibular incisors fit between the first and second maxillary incisors. Functionally the incisor teeth are used with a largely vertical scissor-like slicing action to cut food. During incisor use the cheek teeth are out of occlusion. Incisor wear, growth and eruption are balanced in a normal rabbit at a rate of about 3mm per week.

Cut food is prehended by the lips and passed to the back of the mouth for grinding. Food is ground by the cheek teeth with a wide lateral chewing action, concentrating on one side at a time. The mandible is narrower than the maxilla, and the cheek teeth are brought into occlusion by lateral mandibular movement. The mandible is moved caudally to allow chewing, and the incisors are separated during this phase.

The natural rabbit diet of grasses and other leafy plants is highly abrasive as it has a high content of silicate phytoliths, so there is normally rapid wear of the cheek teeth, around 3mm per month in a wild rabbit, balanced by equally rapid tooth growth and eruption. Mandibular incisors and cheek teeth grow and erupt faster than maxillary teeth.

Maxillary and mandibular bone growth, development and maintenance is also dependent on the mechanical stresses to

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1. Normal incisors, demonstrating the chisel-shaped occlusal surface

which it is subjected. Rabbits which do not spend prolonged periods chewing typically show poor jaw bone development, or atrophy, at muscle insertions. This is most prominent in the area of insertion of the pterygoid (medial) and masseter (lateral) muscles into the ramus; the bone in this area may be so thin that it is transparent or there may even be a perforation where the bone has atrophied completely.

The nasolacrimal duct of the rabbit passes close to the apex of the maxillary incisors and the first maxillary premolar. (Fig 2)

Clinical signs of dental disease

Dental disease is one of the most common reasons for presentation of a rabbit to the veterinary surgeon, although this fact may not be immediately apparent. The commonest signs are:

– Anorexia
– Weight loss
– Facial swellings/asymmetry
– Ocular discharge
– Lack of grooming
– Accumulation of caecotrophs
– Fly strike (myiasis)

Any of these should all alert the practitioner to the possibility of dental disease, and a full dental examination should be carried out. Even in rabbits with no apparent clinical signs, assessment of the teeth should always be an essential part of the clinical examination, with as detailed an examination as is possible in a conscious animal being performed.

Clinical examination

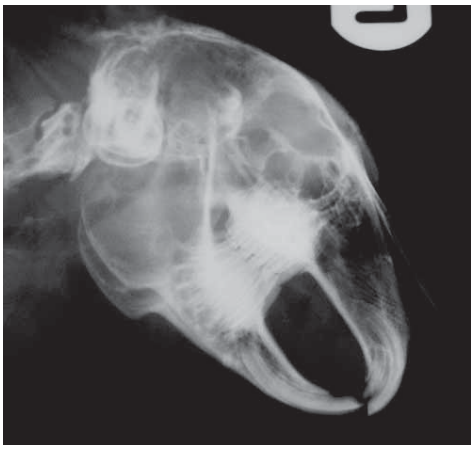
A dental examination should be preceded by a full history, including a detailed dietary history. Clinical examination should include:

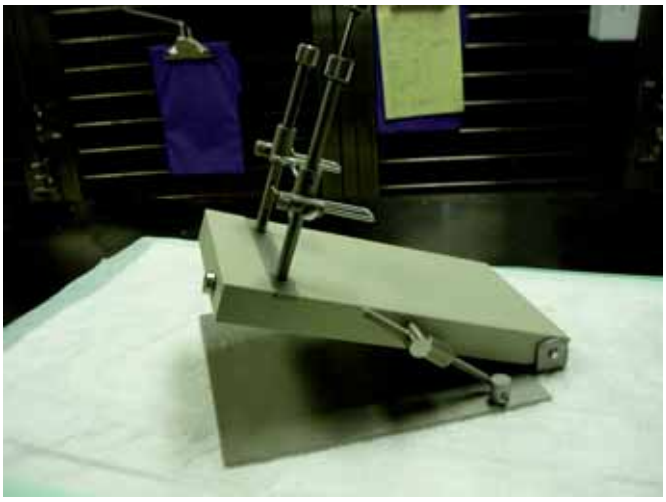
– Facial palpation – for any bony or soft tissue swellings, especially palpation of the ventral border of the mandible where elongated apices may be present.
– Assessment of degree of lateral movement of the mandible
– Examination of length, quality and occlusion of the incisors
– Examination of the cheek teeth

An initial examination of the cheek teeth can be carried out in the conscious animal, with use of an otoscope, although it must be recognised that visibility and detection of abnormalities will be limited. It is estimated that conscious examination will reveal only 50% of abnormalities, however. If dental disease is suspected or lesions are detected in the conscious examination, examination under deep sedation or anaesthesia must be performed. This requires the use of specialist gags and cheek retractors to enable good visualisation (Fig 3). Even then, it is estimated that only 75% of lesions will be detected, with the remainder only being picked up on post-mortem examination (D A Crossley personal communication).

2. Contrast radiography of the nasolacrimal duct, lateral and DV views

4. Normal lateral skull radiograph





3. a) Visualisation of the cheek teeth requires anaesthesia and the use of incisor gags and cheek pouch retractors. (Picture courtesy D.A Crossley) b) A table top gag is also commercially available for this purpose, and allows single-handed oral inspection

Radiography

Abnormalities of the reserve crown and apex can only be assessed radiographically, and radiography is an essential part of a complete dental examination, enabling a full diagnosis, staging and a judgement of prognosis [17]. Computed tomography (CT) is also a very useful diagnostic tool, especially for assessment of dental-associated abscesses, and is being used more widely.

Standard views are dorsoventral and lateral, plus a rostrocaudal view is also useful. After assessment of these, oblique views may be necessary to separate superimposed areas of interest.

When interpreting radiographs, possession of radiographs of a normal animal (Fig 4), and a normal prepared skull, can be very useful. However, it should be recognised that there is a great variety in shape and structure of rabbit skulls depending on breed. The main points to assess are:

– Clinical (supragingival) crown length
– Position of the apices (elongation/intrusion)
– Degree of rostral convergence of the palatine bone and the ventral border of the mandible. In a normal animal there is generally some convergence, while elongation of the cheek teeth leads to this being lost and the palatine bone and ventral border of the mandible becoming parallel or even slightly divergent. There is some breed variation, however.
– Shape of occlusal surfaces – incisors should be chisel-shaped, cheek teeth should show an even zigzag pattern, even when superimposed on the lateral view. Waves or steps may be detected.
– Alveolar bone quality. There should be a fine lucent line between the alveolar bone and the subgingival crown. If this is blurred it can indicate ankylosis. Areas of increased bone lucency may indicate infection or abscessation

5. A large lingual spur is visible on the left mandibular premolar in this rabbit (Picture courtesy D.A Crossley)

Dental disease

Tooth elongation – eruption rate exceeding wear rate

This is the probably the commonest cause of dental disease in pet rabbits and presents as a progressive pattern of abnormalities. Rabbits on a low fibre and high carbohydrate diet have reduced tooth wear or attrition, resulting in elongation of the crown. It is noticeable that rabbits consuming a low fibre mixed grain or pelleted diet tend to crush these items with an "up and down" motion rather than the lateral grinding motion employed when eating a highly fibrous diet. Deficiency of calcium and vitamin D as a result of selective feeding and lack of exposure to sunlight respectively, have also been proposed as causative or exacerbating factors, [9,12] although opinions vary on the significance of these.

Elongation causes occlusion of the cheek teeth at rest, resulting in increased intrusive pressure. As elongation continues, the mandible and maxilla are forced apart (seen radiographically as the palatine shadow and ventral border of the mandible becoming more parallel [13] and the masseter muscles stretched, which also results in increased intrusive pressure. The teeth start to intrude (apices become palpable as bony mandibular swellings) and the crowns tip and/or rotate. Clinically, slight elongation of the supragingival crown is difficult to appreciate, but it is more obvious radiographically. As elongation and disrupted eruption continue the altered forces and reduction in lateral movement during chewing lead to the formation of 'spurs' on the lingual occlusal surface of the mandibular cheek teeth and the buccal

6. a) Wild rabbit mandible, showing short cheek teeth. b) A domestic rabbit mandible, demonstrating elongation of the cheek teeth. (Picture courtesy D.A Crossley)

surface of the maxillary cheek teeth (Fig 5). Spurs or spikes, even as small as 0.1mm, are always significant and indicate a relatively advanced stage of disease, and can cause great discomfort and pain.

Elongation of the cheek teeth prevents the mouth from closing fully (Fig 6). This separates the incisor teeth reducing their wear until they have elongated sufficiently to compensate. Beyond a certain level of elongation the incisors no longer function adequately and occlusal wear abnormalities become apparent, i.e. a secondary incisor malocclusion and elongation occurs (Fig 7). Thus any rabbit presenting as an adult (>3-4 months) with incisor problems should always be checked for cheek tooth disease.

Elongation of the maxillary cheek teeth can impinge on the nasolacrimal duct and cause bony distortion and blockage, resulting in ocular discharge, with or without associated infection. Elongation of the maxillary incisors can have the same effect on the duct more rostrally. Contrast radiography of the nasolacrimal duct is a useful technique (See Fig 2).

7. Lateral skull radiograph showing marked cheek tooth elongation and a secondary (acquired) incisor malocclusion (Picture courtesy D.A Crossley)

The exact pattern of disease progression varies amongst individuals and depends on the degree of elongation and dysplasia. In many rabbits severe dysplasia may eventually result in complete cessation of growth due to ankylosis and resorption of the teeth (see below), which, perhaps paradoxically, can improve or even resolve the associated clinical signs.

Jaw length abnormalities

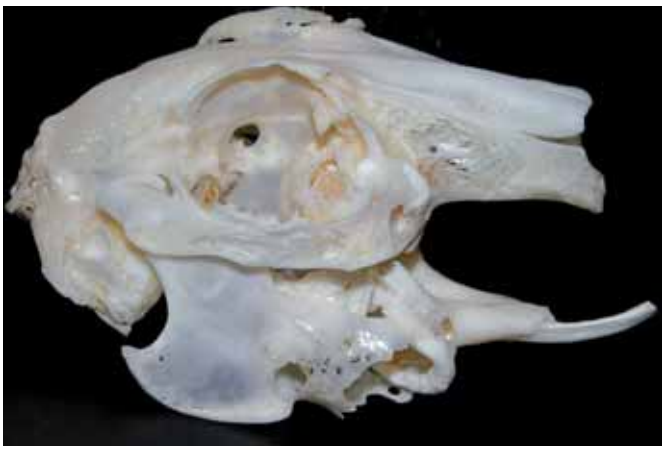
Primary incisor malocclusion and overgrowth is seen with mandibular prognathism/maxillary brachygnathism in some dwarf and lop breeds (Fig 8). In these cases the problem can be detected at a very early age. It is common for the mandibular incisors to become straighter preventing any correction of the problem in mild cases. The maxillary incisors are not worn, but contact with the mandible maintains occlusal pressure so the tight spiral curvature of growth continues, the teeth eventually penetrating the palate or cheek if left untreated. Regular crown reduction or, preferably incisor extraction, is indicated for affected animals.

Traumatic injury

Separation of the mandibular symphysis is the most common accidental injury. Pulp exposure may occur associated with

8. Primary incisor malocclusion

9. Pus present at the mandibular incisors, which have stopped growing, as a result of pulpitis and abscessation subsequent to repeated trimming with nail clippers



10. Prepared skull showing extensive bony distortion associated with mandibular and maxillary tooth root abscessation (Picture courtesy D.A Crossley)

both dental fractures and trimming by a veterinary surgeon. If the exposure is small and the blood supply to the pulp is undamaged it may heal unaided, but many cases require partial vital pulpectomy and vital pulp therapy, a specialist procedure. In untreated cases pulpitis and pulp necrosis are common, with the formation of abscesses around the premolar tooth roots days to months later (Fig 9).

Periodontal disease and facial abscesses

Periodontal disease is common in rabbits, especially as the weak structure of periodontal ligament renders it more likely to injury and food impaction Elongation is a significant factor, especially with the cheek teeth, as this causes disruption of the tightly packed occlusal surface and the opening up of gaps (diastemas) between the teeth. Periodontal infection, often with anaerobic oral bacteria such as Fusobacterium species, or Staphylococcus. or Streptococus spp. [16] may spread to the tooth apex, leading to endodontic lesions as the infection affects the pulp. Abscesses frequently result from periodontal infection, or mucosal damage caused by dental 'spikes'. Unfortunately most dental abscesses result in gross changes in the surrounding tissues including the alveolar bone, so that there are residual problems even if the abscess is successfully treated. If not treated early, abscesses tend to behave as expansile masses, and they can displace teeth (Fig 10).

Dental caries and resorption

High carbohydrate diets, reduced attrition and arrested eruption predispose to caries (demineralisation), which can totally destroy the exposed crown and progress subgingivally stimulating resorption. Resorptive lesions are also seen associated with periodontal disease and abscesses. If affected animals survive long enough, replacement resorption may eventually result in the disappearance of most of the cheek teeth. Affected rabbits often do well on a suitably processed diet, though there are continuing problems with progressive eruption remaining non-occluding teeth.

Prevention and treatment of dental disease

If rabbits are fed on fresh and dried grasses and other herbage, dental disease is generally rare. Unfortunately the incidence in some, particularly extreme dwarf and lop breeds, approaches 100% whatever their diet.

Coronal reduction

When detected in its very earliest stages, uncomplicated tooth elongation can be corrected simply by dietary change. Established tooth overgrowth may be helped by repeating burring at 4 to 6 week intervals. Radiographic assessment of tooth roots is essential in all cases before undertaking treatment.

Incisors

In the unlikely event that problems are restricted to the incisor teeth then these can easily be trimmed back to a normal length and shape, or if repeated treatment is needed they can be extracted. Incisor trimming can be performed without difficulty in conscious animals using either high or low speed dental equipment. A high speed handpiece rotating at 2-400,000 times a second will cut the teeth with minimal effort, but care should be taken to avoid overheating. Low speed burrs can also be used but they are less efficient, and should only be applied for a maximum of 5 seconds before removal to allow cooling. Diamond discs are hazardous and not recommended. Taper fissure burrs are most efficient with either high or low speed handpieces, and soft tissues should be protected, e. g by placing a wooden tongue depressor behind the incisors. The aim is to restore normal crown height and the chisel shape. Care should be taken not to expose the pulp. In the normal incisor pulp is unlikely to extend more than 3mm above the gingival, but this may be much more (up to 17mm maxillary, 27mm mandibular) in the overgrown incisor [6]. If exposed, vital pulp therapy using calcium hydroxide cement is required, generally a specialist procedure. Clippers should never be used as they leave sharp edges and longitudinal cracks in the teeth and will often expose the pulp. Clipping also releases a considerable amount of energy

11. An example of a low speed dental machine and handpiece

12. Coronal reduction of cheek teeth using a low speed handpiece with taper fissure burr and protector (Picture courtesy D.A Crossley)

into the tooth, concussing the pulp, and damaging the highly innervated periodontal and periapical tissues, causing pain.

Cheek teeth

Coronal reduction of cheek teeth requires general anaesthesia, and specialist mouth gags and cheek dilators. A straight slow speed dental handpiece (Fig 11) with a long-shanked taper fissure burr is recommended. A burr protector may be used (Fig 12). Avoidance of soft tissue trauma is vital, but can be difficult due to the limited space and visualisation. Moistening the teeth with a damp cotton bud can help prevent the burr "walking off" the tooth. Hand held molar clippers may be used initially to remove large spikes. There is little point in simply removing sharp edges or 'spikes' as the main problem, tooth elongation, is not then addressed. Hand held rasps are often too coarse and not favoured by the author, as the forces applied can lead to tearing the periodontal ligament and loosening teeth. However, if powered equipment is not available, molar clippers (Fig 13) and fine diamond rasps may be used.

The aim of coronal reduction is to shorten the crown and attempt to restore the normal occlusal pattern. The stage of disease will influence the treatment – in the early stages where apical changes are minimal, restoration of normal anatomy and function may be possible, but unfortunately this is seldom the case as rabbits are not presented until the disease has reached a later stage. In later stages, where changes in tooth morphology are extensive, burring is palliative only, to remove painful spikes and spurs and reduce crown height. Where changes are very severe and eruption has ceased due to ankylosis or major damage to the periapical tissues, coronal reduction is not indicated as the teeth cannot grow again to restore occlusion and chewing ability will be removed. In summary, coronal reduction is advocated until eruption has ceased. Coronal reduction takes teeth out of occlusion, removing intrusive pressure, so allowing teeth to erupt as normally as possible. Radical reduction may expose sensitive dentine and cause discomfort. Burring removes the transverse occlusal ridging so chewing efficiency is greatly reduced until occlusion is resumed and ridging re-forms through differential wear. It also may take some time for the jaw muscles to recover their ability to contract fully after radical coronal reduction. Repeated treatments, initially at 4-6 week intervals, are generally necessary, but these intervals will generally increase as the pattern of cheek tooth eruption becomes apparent

Early caries may be eliminated by burring away the affected tissue. However, they often re-form unless the diet is corrected and the coronal reduction may result in abnormal wear of opposing teeth. Periodontal pockets deeper than 3mm are difficult to clean in rabbits. Standard subgingival curettes may be used but small dental excavators are often more effective. Deeper pocketing is usually associated with abscessation in which case the tooth will need extracting. This will also result in abnormal wear of opposing teeth.

Extraction of teeth

Principles of extraction in rabbits are the same as for removal of brachydont teeth in cats and dogs, i.e:

– Assessment
– Treatment planning
– Anaesthesia
– Cleansing of the operative field
– Incision of the gingival attachment
– Severance of the periodontal ligament
– Enlargement of the alveolus
– Removal of supporting alveolar bone if necessary
– Gentle lifting of the detached tooth from its socket
– Encouragement of formation of a stable alveolar blood clot

Analgesia must be provided in the post-operative period. The rabbit should be bright, alert and eating within 2-4 hours postoperatively following appropriate anaesthesia and analgesia. If substantial soft tissue or bone trauma was present (or created iatrogenically) then a nasogastric tube may be used for nutritional supplementation until the rabbit is able to eat normally. The animal should be weighed daily in the post-operative period to ensure weight loss does not occur. Food items must be prepared in bite sized particles; vegetables may be chopped or grated. If

13. Dental equipment available for rabbits. From left to right: molar cutters, Crossley molar elevator/luxator, molar extraction forceps, incisor gag, cheek dilators, Crossley incisor elevator/luxator, rasp [(d)]

the animal does not eat voluntarily within 4 hours, nutritional and fluid support must be instigated. The normal rabbit uses the incisors for grooming, so if these have been removed the rabbit should be groomed regularly to prevent matting of the coat.

Incisor removal

Radiography is required before incisor removal to establish any associated pathology and molar involvement [2]. The gingival attachment around the incisor is cut using a hypodermic needle or a no 11 scalpel blade. An incisor elevator/luxator (See Fig 13) (or blunted hypodermic needle) is then inserted along the mesial aspect of the tooth to break down the periodontal ligament. The elevator should follow the line of the tooth taking into account its natural curvature. Gentle but sustained pressure is exerted on the mesial and distal aspect of the tooth until it is loosened – it is generally not necessary to luxate the ligament on the buccal or lingual/palatal surfaces as it is so weak here. Once loosened, the tooth should be gently rotated and pressed back into the socket to destroy apical germinal tissue – failure to do this will result in tooth regrowth, and even when this is done incisors will occasionally regrow [14]. Alternatively, the apical tissue may be debrided with a small curette after extraction of the tooth. The tooth is then extracted using gentle traction. Excessive traction may result in fracture of the teeth especially if they are of poor quality. All 6 incisors should be removed; the small incisors (peg teeth) require minimal luxation. The alveolus may be packed with an anticoagulant sponge to limit haemorrhage in the post operative period. The gingiva may be left to heal by granulation, or closed with fine (5/0) absorbable suture material. If a tooth breaks, the rabbit can be re-presented a few weeks later when the crowns have re-erupted for completion of the extraction. If the periapical tissues have been damaged, regrowth may not occur and surgery may be required to retrieve the stump before it serves as a nidus for infection or progresses to tooth root abscessation.

Cheek tooth extraction

Cheek tooth extraction can be very difficult unless the tooth is already loosened by periodontal disease. The most common cause for extraction is in association with facial abscess treatment (see below). Some abnormal cheek teeth may be extracted per os by simple traction if the periodontal ligament is weak or root pathology is such that the tooth is loose. The curvature of the tooth should be taken into account when attempting to extract the tooth. If the periodontal ligament is still intact, it may be broken down using a modified elevator and the tooth extracted orally (see Fig 13 for molar elevator/ luxator and extraction forceps). The small size of the oral cavity relative to the instrument makes intra-oral manipulation of the tooth difficult. Once loosened the tooth should be intruded into its alveolus and manipulated to help destroy any remaining germinal tissue prior to removal. The pulp should remain in the extracted tooth. If not, the germinal tissues are probably intact and should be actively curetted using a sterile instrument. If the germinal tissues are left intact the tooth will regrow, possibly as a normal tooth, but more likely with gross deformity, in some cases forming a pseudo-odontoma within the jaw bone.

Ankylosis of the tooth makes extraction very difficult and an open technique is required. The removal of a molar via a buccotomy incision, removal of alveolar bone and replacement of a gingival flap requires careful technique and intensive post-operative care to ensure a successful recovery.

It should be remembered that each molar opposes with two others. These teeth may need corrective trimming following extraction of one opposing tooth and so the rabbit should be checked regularly.

Treatment of dental abscesses

The three main components of successful dental abscess treatment are:

– Surgical removal/debridement of the abscess and any associated teeth and infected bone
– Local antibiosis
– Systemic antibiosis

Surgical removal should be extracapsular where possible and all associated teeth and infected bone must be removed. A common reason for recurrence of abscesses, in the author's opinion, is failure to perform sufficiently aggressive surgery. Radiography is an essential part of the pre-surgical assessment, in order to identify which tooth/teeth are involved and the extent of involvement of the surrounding tissues.

Local antibiosis may be achieved in several ways. Installation of antibiotic-impregnated polymethylmethacrylate (AlPMMA) beads into the defect created by surgical removal is a common technique that allows locally high antibiotic levels with little systemic absorption [1,15]. Systemic antibiotics are given for 2-3 weeks post-operatively. The choice of antibiotic should preferably be based on culture and sensitivity results. PMMA with gentamicin already incorporated may be purchased directly (e.g Refobacin® Bone Cement R [(a)]). Pre-made beads are available (e.g Septopal® [(b)]) but these are often too large for use in rabbits. AlPMMA beads are rapidly encapsulated by

fibrous tissue, after which only tissues up to 3mm away receive the high concentrations of antibiotic. Thus placing them within the abscess capsule will be ineffective. The author and others (David Crossley personal communication) have had good success filling the surgically-created defect with doxycycline gel (e.g Atridox® [(c)]). This is also useful for packing defects secondary to periapical infection. Both these techniques involve closure of the wound, enclosing the implant. AlPMMA beads do not generally need to be removed, as they are biologically inert. Packing the cavity with calcium hydroxide is favoured by some but has been reported to cause serious tissue damage and necrosis [1].

An alternative technique of achieving local antibiosis is to marsupialise the surgical cavity and allow it to heal by granulation, while flushing with or instilling antibacterial/antibiotic solutions. This technique has the advantage of allowing more control over continued treatment of the site and easier monitoring and detection of recurrence.

Systemic antibiosis is generally not necessary for more than 2-3 weeks post-operatively in case surgery causes a bacteraemia. However, in cases where complete excision is not possible, long term systemic antibiosis may be necessary. Long term use of antibiotics that have good efficacy against the anaerobic organisms involved with dental abscesses, such as penicillin G (by subcutaneous injection, never orally) are anecdotally reported to have good success in preventing progression of abscesses, or helping to achieve a cure when combined with surgical debridement.

(a) Biomet Cementing Technologies AB, Forskaregatan 1, SE-275 37Sjöbo,Sweden www.bonecement.com
(b) BioMet Europe, Dordrecht, Netherlands
(c) CollaGenex Pharmaceuticals Inc. 41 University Drive, Suite 200 Newtown, PA 18940
(d) Veterinary Instrumentation Limited, Broadfield Road, Sheffield, S8 OXL United Kingdom. www.vetinst.com

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