Equine vet. Educ. (2004) **16** (3) 151-158

Tutorial Article

Oral extraction of equine cheek teeth

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Keywords: horse; teeth; dental extraction; apical infection; diastema; peridontal disease

Introduction

After years of little progress, the increased interest in equine dentistry in recent years has stimulated an increased desire to develop new techniques to treat dental disease and to re-evaluate traditional techniques (Dixon 1993).

The most frequent indications for dental removal are apical infections, supernumerary cheek teeth or severe diastema with associated periodontal disease. Currently, in many cases with either chronic apical infections or advanced diastema, with associated food impaction and periodontitis, conservative treatments are unsuccessful and dental removal remains the main course of treatment (Dixon *et al.* 2000). Dental extraction has been practised in the conscious horse since the turn of the century with little modification in the available techniques (O'Connor 1942).

The technical difficulties and development of improved sedatives and anaesthetics in the latter half of the last century contributed to the search for alternative, more invasive techniques, and consequently dental repulsion became widely practised. The technical problems with this technique and the high incidence of complications (Prichard *et al.* 1992; Dixon *et al.* 2000), such as dental or alveolar sequestration or continuing paranasal sinusitis, necessitated further investigations. Removal of the rostral 4 mandibular cheek or the rostral 3 maxillary cheek teeth via a lateral alveolar buccotomy is an alternative technique to repulsion and was reported to be associated with a lower incidence of complications (Evans *et al.* 1981; Lane 1987). However, this technique is technically more complicated, always necessitates general anaesthesia and iatrogenic damage to branches of the dorsal buccal nerve or parotid salivary duct is a possible complication (Easley 1999).

More recently, oral extraction techniques originally described by Merillat (1906) have been reviewed and found to be successful in both conscious sedated and anaesthetised horses. Since 1995, extraction *per os* has been the author's technique of choice for dental removal and has been associated with a considerably reduced incidence of complications than that associated with repulsion (Tremaine 1987; Dixon *et al.* 2000). The probability of a successful extraction is considerably hindered by previous unsuccessful attempts at dental removal or where there is a fracture involving the clinical crown.

Despite some attempts to treat apical abscesses with apicectomy and endodontic treatment (Baker and Kirkland 1992; Butson *et al.* 1997), the technical difficulties in such treatments have resulted in limited success. Improvement in understanding of the aetiopathogenesis of apical infections, combined with more sensitive diagnostic techniques such as scintigraphy and computed tomography, may enable improvements in endodontic techniques, leading to improved success in the future (Boswell *et al.* 1999, 2001).

Indications for oral extraction

Apical abscesses and severe diastema, or dental displacements with food pocketing and gingivitis, are progressive conditions and conservative treatments are usually disappointing, possibly because many of these cases are chronic before veterinary attention is sought. Mandibular apical abscesses and rostral (Triadan 106–108, 206–208) maxillary cheek teeth infections typically present with a firm, nonpainful swelling over the affected cheek tooth apex, possibly associated with a discharging tract in the most chronic cases. Apical infections involving the caudal mandibular cheek teeth (310, 311, 410, 411) may also present with possibly painful swelling involving the masseter muscles or pharyngeal and submandibular areas. Apical abscesses of the more caudal (108–111, 208–211) maxillary cheek teeth commonly discharge into the rostral or caudal maxillary sinuses and cause a secondary bacterial sinusitis.

Careful oral examination with a full mouth gag usually identifies the **presence of food pocketing**, due to diastemata or displaced or supernumerary teeth, which leads to periodontal disease, and a digital examination or exploration with a dental pick or molar forceps can reveal **loose** or **fractured** cheek teeth or the presence of putrefying impacted food between the cheek teeth, confirming the presence of diastema or a dental fracture.

The occlusal surfaces of cheek teeth with **apical abscesses** commonly show no gross defects although, in some cases, close inspection of the occlusal surfaces reveals pits or caries,

Fig 1: Injection of mepivicaine at the mandibular foramen (arrows) will desensitise the inferior alveolar nerve and assist with analgesia of the mandibular teeth.

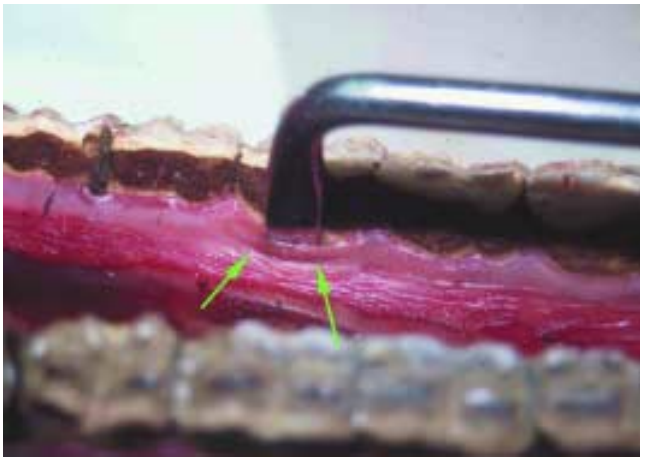

Fig 2: The gingiva is elevated using a flat dental pick to expose more of the clinical crown (arrows).

which potentially communicate with the dental pulp chambers. Apical abscesses occur most commonly in horses with median age 6 years for mandibular and rostral maxillary cheek teeth, and median age 8 years for caudal maxillary cheek teeth, with the 2nd and 3rd mandibular (307, 308, 407, 408) and the 2nd and 4th maxillary cheek teeth (107, 109, 207, 209) most commonly being infected (Dixon *et al.* 2000).

Primary periodontal disease is rare, but in horses with dental displacements and diastema, 87% of 39 horses showed periodontal disease (median age 7 years) (Dixon *et al.* 2000). In horses with periodontal disease, where the periodontal attachments are weakened, and in aged horses, in which the reserve crowns are shorter, dental extraction *per os* can easily be performed. O'Connor (1942) reported that "*to extract a molar tooth from a sound alveolus in a young horse is almost an impossible task*"; however, using modern sedative analgesic

Fig 3: Molar separators are carefully placed rostral and caudal to the tooth which is to be extracted, in order to stretch and loosen periodontal attachments. Excessively forceful application of molar separators can result in fracture of the crown of the tooth.

Fig 4: The molar extractors are placed on the tooth, frequently checking their position before closure. Care must be taken to avoid inadvertantly grasping part of the teeth rostral or caudal to the affected tooth.

Fig 5: Molar extractors come in varying sizes, with different methods for locking the handles.

Fig 6: The width between the jaws is wider for maxillary cheek tooth extractors (b) than for those used for extracting mandibular teeth (a), and there is variation in the width of the teeth between individual horses.

Fig 7: Once in place, the molar extractors' handles can be fastened by a rubber tourniquet, although adhesive tape or self-locking mechanisms can also be used.

Fig 8: The extractors are slowly oscillated in a horizontal plane to commence rotating the tooth around its sagittal axis, thereby stretching the periodontal ligament and distorting the dental alveolus.

Fig 9: After many repetitions of the horizontal movement of the dental extraction forceps, foamy blood is visible at the gingival margin (arrows) and a 'squelching' sound can be heard.

Fig 10: Different styles of dental fulcra are available, which vary in width to enable extraction of different teeth.

Fig 11: The fulcrum (arrow) is placed on the cheek teeth row rostral to the tooth to be extracted, under the hinge of the molar extractors.

techniques and appropriate instrumentation, this is no longer true. Extraction of cheek teeth *per os* is substantially more difficult in younger horses, especially those with apical abscesses, in which there is no gross periodontal destruction, but modern sedative/analgesic drugs have greatly facilitated this technique, although the potential for iatrogenic damage remains high.

Ancillary diagnostic techniques

A full series of radiographs should be performed on those horses with mandibular or maxillary swellings or paranasal sinusitis possibly associated with dental apical infection. Straight lateral, lateral 30°dorso-lateral and dorsoventral projections are usually performed for radiography of the maxillary cheek teeth rows and straight lateral, lateral 45°ventro-lateral and dorsoventral projections for the mandibular rows (Tremaine 2000). In addition, open-mouthed oblique views are extremely useful for inspection of the coronal aspects of the cheek teeth (Barakzai and Dixon 2003) in horses with displaced diastematous, fractured or supernumerary teeth. The use of blunt metal probes introduced into discharging tracts is helpful to identify the tooth involved in a periapical abscess. The limitations of radiographs in equine cheek teeth disorders have been described (Gibbs and Lane 1987; Weller *et al.* 2001), and identification of the presence and position of a diseased tooth may be assisted by other ancillary techniques such as **gamma scintigraphy** or **computed tomography** (the latter currently available in a very limited number of centres). Gamma scintigraphy appears to be **more sensitive than radiography** for detecting early dental apical and alveolar inflammation (Weller *et al.* 2001). Despite the use of these ancillary techniques, the identification of an affected cheek tooth in horses with sinusitis can be frustrating and inspection of the suspect dental apex via a trephine or bone flap osteotomy is ultimately necessary in some cases. Dental removal should never be undertaken where doubt remains as to whether the tooth is affected.

Restraint

Extraction *per os* is considerably less traumatic than repulsion or extraction via a lateral buccotomy, and most horses tolerate the procedure under standing chemical restraint, although general anaesthesia is necessary in a small proportion of nervous or fractious horses.

The costs and risks associated with equine general anaesthesia mean that the ability to extract cheek teeth in conscious sedated horses offers considerable advantages. Even if attempted extraction in sedated horses is unsuccessful, extraction *per os* performed under general anaesthesia has advantages over other techniques in view of the reduced incidence of complications and post operative care. In those horses where the initial attempt at extraction *per os* is unsuccessful, subsequent repulsion or removal via a buccotomy is greatly facilitated by the weakening of some of the periodontal attachments, thereby reducing the enormous forces needed to repulse a tooth with intact periodontal attachments.

Case selection

Extraction *per os* is currently the technique of choice for dental removal in most horses. Extraction of the caudal teeth (Triadan 110, 111, 210, 211, 310, 311, 410, 411) is technically more difficult because the limited range of opening of the equine mouth frequently impairs accurate instrument placement, and the opposing row of teeth can hinder extraction of teeth with long reserve crowns. Oral extraction of fractured cheek teeth is sometimes possible if there is a sufficiently large parent fragment, but many fractured teeth do not need to be extracted, especially where the pulp cavities are not involved. Typically, these teeth, most commonly maxillary cheek teeth (Dixon *et al.* 2000), have a parasagittal lateral slab fragment which does not involve the pulp and which can be removed without difficulty, and a larger nondisplaced stable fragment which does not require removal. However, oral extraction of teeth with severe caries usually results in fragmentation of the tooth, which may necessitate subsequent removal of dental sequestra at a later stage. In horses with maxillary apical abscesses with secondary bacterial sinusitis, dental extraction *per os* is possible but, in addition, surgical drainage of the affected sinus cavities is often necessary. In some chronic cases, removal by repulsion followed by sinus curettage and lavage is indicated, particularly where inspissated pus is present. Oral extraction should not be attempted in conscious horses of unsuitable temperament, where the safety of the horse or personnel may be at risk. Dental extraction is contraindicated where doubt remains over the aetiology of the sinusitis or where identification of the affected apex is unclear (Lane 1994).

Extraction *per os* in the standing horse is best achieved with the horse restrained in stocks, with the head supported on a rigid headcollar or head-stand. Cheek tooth extraction constitutes a major surgical procedure, especially in younger horses, and effective sedation and good analgesia are prerequisites. An alpha-2 agonist, such as romifidine, detomidine or xylazine, in combination with opioid analgesics such as butorphanol or morphine, provides effective sedation/analgesia, with the choice of drug protocol depending on the environment, temperament of the animal and individual preference (Ramzan 2002). Desensitisation of the inferior alveolar nerve at its entry into the caudal mandibular foramen (**Fig 1**) may additionally improve analgesia of the mandibular teeth (Scrutchfield *et al*. 1996).

Extraction *per os* under general anaesthesia

Extraction *per os* necessitates good access to the oral cavity involving the use of bulky instrumentation in a limited space. When extraction is to be performed under general anaesthesia, a narrow-diameter, cuffed endotracheal or nasotracheal tube should be used to prevent inadvertant inhalation of exudates, while still allowing sufficient remaining space to perform the extraction. The horse is placed in lateral recumbency with the affected tooth uppermost.

Technique for oral extraction

The techniques described by O'Connor (1942) and Guard (1951) have been modified. Antibiotics are routinely given preoperatively. A bright head-light is necessary for accurate instrument placement. The gag (speculum) is inserted and opened sufficiently wide to allow digital palpation to clearly identify the tooth to be removed. After visually and digitally identifying the tooth to be extracted, the gingiva on the buccal and palatal or lingual aspects of the affected tooth are elevated from the tooth using a flat-bladed dental pick or small periodontal elevator (**Fig 2**). Molar separators are placed rostral and then caudal to the affected tooth to loosen the rostral and caudal periodontal attachments (**Fig 3**). When extracting a second cheek tooth, the molar separators should not be used between the first and second cheek teeth because of the high risk of inadvertant loosening of the healthy first cheek tooth (Triadan 106, 206, 306, 406), nor between the caudal two teeth. Aggressive use of the molar seperators is unnecessary and also increases the risk of inadvertantly loosening a healthy tooth, or fracturing the crown of the affected or adjacent teeth.

The molar extractors can then be placed on the tooth (**Fig 4**). Molar extractors come in different sizes and no single instrument is perfect for every tooth (**Fig 5**). Mandibular cheek teeth are narrower than their maxillary counterparts and therefore require an instrument with a narrower space between the jaws when the handles are closed (**Fig 6a**) Maxillary teeth usually require a wider instrument (**Fig 6b**). Good instrument-tooth contact is essential, and instruments with toothed or knurled jaws are preferable. A visual inspection, to ensure that the correct tooth is grasped and that the instrument jaws do not extend onto the adjacent teeth, is performed. If no repositioning is necessary, the extractor handles are then fixed using the locking mechanism, a rubber bandage or adhesive tape (**Fig 7**).

The extractors are oscillated with slow, low amplitude movements in the horizontal plane only, around an axis down the centre of the sagittal axis of the cheek tooth (**Fig 8**). A visual inspection during the first few oscillations should be performed to ensure that the extractor has maintained the grip on the tooth and that the tooth is moving slightly. Incorrect or loose placement of the molar extractors can result in abrasion of the clinical crown, which becomes rounded and is then impossible to grip on subsequent attempts. There should be no twisting movement along the axis of the extractor handles, which can result in fracturing of the clinical crown.

The amplitude of the oscillations is increased **slightly** as the tooth becomes loose, but excessive force or attempts to perform large oscillations should be avoided, since they can result in shearing of the clinical crown before periodontal attachments are loosened. When the periodontal attachments are loosened, a distinctive 'squelching' sound can be heard, and the resistance to oscillation of the extractor decreases. This is frequently accompanied by fresh foamy haemorrhage around the gingival margins (**Fig 9**). In addition to disrupting the periodontal membrane, it has been suggested that this loosening contributes to stretching the alveolus, also facilitating extraction (J. Easley, personal communication). Several hundred oscillations, possibly taking >2 h, may be necessary before the tooth is sufficiently loose to extract. Some authors recommend postponing the extraction until the following day, when alveolar haemorrhage may have contributed to further loosening of the tooth (J. Easley, personal communication).

A dental fulcrum (**Fig 10**) appropriate to the extractors is advanced to lie between the extractors and the cheek tooth rostral to the affected tooth (**Fig 11**). The **mechanical advantage is maximised** by advancing the fulcrum as far as possible along the row of cheek teeth. While keeping the molar extractors firmly gripped on the affected tooth, firm pressure is applied to the handles to lever the tooth over the fulcrum and extract it in a straight line parallel with its long axis (**Fig 12**). **Once the tooth has been partially extracted**, it may be necessary to release the extractors and replace them in a more apical position to extract the remaining part of the tooth. **Axial twisting** of the extracting forceps along their length **should be avoided** until the tooth has been totally freed from periodontal attachments. However, **once the tooth is partially extracted**, it may be necessary to direct the clinical crown medially to allow extraction of the apical portion without obstruction from the opposing row of cheek teeth (**Fig 13**). Loosening of the caudal (5th and 6th) cheek teeth in young (age >7 years) horses can be particularly frustrating, possibly due to their obliquely caudally angled reserve crowns. Such teeth may require sectioning to allow their total extraction from the deep alveoli, although this must be done with care to prevent the apical portion from returning deep into the alveolus after it is sectioned, from where it is technically difficult to retrieve.

Once extracted from the alveolus, the tooth is withdrawn from the mouth and inspected for integrity, paying special attention to the apical area. The alveolus should then be carefully palpated digitally for the presence of remaining dental fragments or alveolar bone fragments. If remnants are present, the alveolus is carefully curetted (**Figs 14**, **15**) until smooth to digital palpation and no dental fragments remain. Individual roots may fracture during an extraction, but these do not appear to require repulsion in all horses, unless infected dental or alveolar remnants remain. **Post extraction radiographs** should be taken if the tooth fractured during extraction and dental fragments may remain.

In mandibular or rostral maxillary cheek tooth extractions (with no associated external sinus tracts), the alveolus may temporarily be loosely packed with dental wax, impression compound (Kerr Impression Compund[1]; Panasil soft putty[2]) or a gauze swab soaked in an antibacterial solution (or metronidazole paste). The packing will gradually be forced out as the alveolus fills with organising granulation tissue. Care must be taken to avoid sealing infected or necrotic fragments into the alveolus.

In horses with **dental disease associated with an external sinus tract** or secondary paranasal sinusitis, the alveolus may require sealing from the maxillary sinus to prevent development of an orosinus fistula. In such cases,

Fig 12: Once the tooth is digitally loose, the tooth can be levered out by exerting vertical force on the extractors over the fulcrum. Excessive resistance necessitates further loosening of the tooth before attempting extraction.

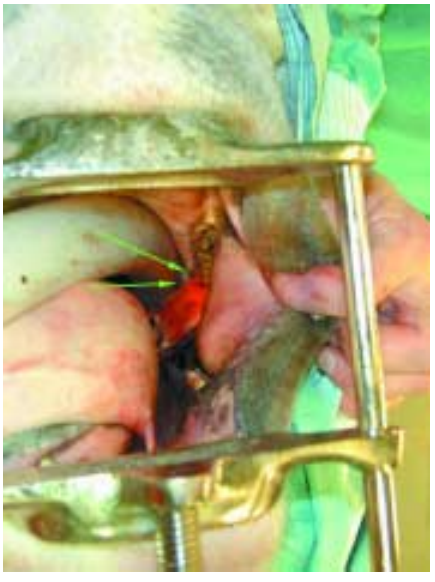

Fig 13: It may be necessary to direct the partially extracted tooth (arrows) medially to enable complete removal of the tooth from the alveolus.

Fig 14: Once the tooth is removed, the alveolus (arrows) can be palpated and any remaining dental fragments curetted, taking care to avoid damage to the adjacent teeth.

Fig 15: Right-angled dental picks and curettes enable fragments to be removed from the alveolus.

Fig 16: In cases with sinusitis secondary to dental apical abscessation with inspissated material in the maxillary sinuses, removal of infected material may be necessary via a bone-flap osteotomy.

treatment of the sinusitis by surgical debridement (**Fig 16**) or lavage via a lavage catheter may be necessary.

The dental alveolus can be sealed using orthopaedic polymethylmethacrylate bone cement[3] (**Fig 17**) or dental impression compound placed in the alveolar cavity (Dixon 1997). The alveolus should be cleaned and dried with gauze swabs before prosthesis placement. The methylmethacrylate prosthesis is moulded to approximately one-third of the length of the alveolar cavity, placed while still malleable and pressed into the alveolus to be flush with the gingival margins. Methacrylate protruding into the gingival margins can result in a flange (**Fig 18**), which facilitates removal of the implant by the horse's tongue. Excessively long prostheses appear to result in delayed alveolar healing.

Aftercare

Minimal aftercare is necessary after oral extraction. However, nonsteroidal anti-inflammatory drugs are suitable to provide analgesia for 24–72 h. A soft or soaked diet can be fed for a few days post operatively. Sinus lavage for several days may be necessary in those cases with an associated sinusitis. A digital inspection of the alveolus (**Fig 19**) 12–14 days post operatively for any remaining dental fragments is beneficial in those cases where the tooth was extracted in more than one fragment.

Fig 17: In cases with maxillary sinusitis, the oral cavity must be sealed from the sinus to prevent a persistent fistula. Cold-curing polymethylmethacrylate bone cement is one product suitable for this use. Such products are also available impregnated with antibiotics.

Fig 18: Alveolar plugs with an excessively large flange can be displaced prematurely by the action of the horse's tongue.

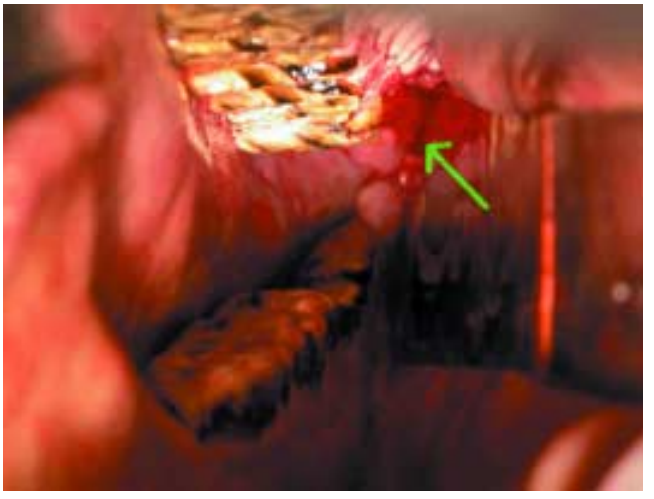

Fig 19: The dental alveolus (arrow) can be digitally inspected post operatively for the presence of any remaining fragments.

Fig 20: Inappropriate or forceful action of the extractors can result in fracture of the crown of the tooth with pulpal exposure, necessitating subsequent repulsion of the remaining apical fragment.

Complications

Although complications after dental extraction *per os* are rarer than after repulsion (Dixon *et al.* 2000), with only 2 of the first 49 cases of oral extraction performed at the University of Edinburgh (Tremaine 1987) showing complications, serious problems can occur. Dental extraction can be technically difficult and **fracture of the affected tooth**, with retention of the apical portion, can occur, necessitating repulsion of its apical portion. Dental fracture (**Fig 20**) frequently results in pulpal exposure and contamination from the oral cavity, which can lead to apical infection.

Incorrect instrument placement can result in iatrogenic damage to healthy adjacent teeth (Dixon *et al.* 2000). Excessive use of force while loosening the tooth, or when removing from the alveolus, can occasionally result in mandibular fracture, especially when extracting caudal mandibular teeth in young horses. **Ill-fitting bone cement prostheses** can be displaced prematurely, resulting in food impaction in the cavity and formation of an orosinus fistula following extraction of the caudal maxillary cheek teeth (Triadan 108–111, 208–211). In some situations the **dental alveolar plugs may become loose**, allowing food into the alveolus, which is associated with discomfort. In such instances the implant is removed, and this can be facilitated by leaving a slight flare on the gingival margin when placing the plug, although an excessively large flare may result in premature plug removal (**Fig 18**).

After dental removal, the opposing tooth will grow faster with reduced attrition from mastication, and frequent (e.g. biannual) dental rasping will be necessary to avoid a 'step-mouth' occurring. Following dental removal, some dental drift will occur in the affected row to close the gap resulting from the extraction, which can, in the long term, result in diastema between other teeth in the same row. **Continuing nasal discharges** in cases with secondary

sinusitis indicate the presence of remaining dental sequestra or inspissated pus or food material in the maxillary sinuses, which require further investigation and treatment.

Conclusions

Extraction of cheek teeth *per os* is a viable alternative to other techniques for dental removal in selected cases. The ability to perform extraction *per os* in standing sedated horses, in combination with the relatively low incidence of complications, offers considerable advantages over other techniques. Cases with lesions affecting the rostral 3 cheek teeth in horses age >8 years are most easily extracted *per os*. However, extraction *per os* is possible with caudal cheek teeth and cheek teeth in young horses, and each case should be evaluated indvidually. Dental apical infections associated with secondary paranasal sinusitis have an increased risk of complications after treatment and dental removal under general anaesthesia may be indicated in such cases, if debridement of the sinuses via a bone flap is required or if the animal's temperament renders a standing procedure unsafe. **Complications associated with dental removal can occur even when performed by experienced clinicians with a full range of instruments, and veterinarians without the appropriate facilities are not advised to attempt it except in older horses or where periodontal disease is severe. Clients should be advised of the risk of complications and possible high costs before commencing any extractions, although the technique compares favourably with repulsion and extraction via a lateral buccotomy.**

Acknowledgements

The author is indebted to Professor P. M. Dixon for assistance with the manuscript and development of the technique.

Manufacturers' addresses

[1]Kerr UK Ltd., Peterborough, Northamptonshire, UK.
[2]Kettenbach Ltd, Eschenberg, Germany.
[3]Depuy CMW3, Blackpool, Lancashire, UK.

References

Baker, G.J. and Kirkland, K.D. (1992) Endodontic therapy in the horse. *Proc. Am. Ass. equine Practnrs.* **38**, 329-335.

Barakzai, S. and Dixon, P.M. (2003) A study of open-mouthed oblique projections for evaluating lesions of the erupted clinical crowns. *Equine vet. Educ.* **15**, 143-148.

Boswell, J.C., Schramme, M.C., Livesey, L.C. and Butson, R.J. (1999) Use of scintigraphy in the diagnosis of dental disease in 4 horses. *Equine vet. Educ.* **11**, 294-298.

Boswell, J.C., Schramme, M.C., Livesey, L.C., Butson, R.J., May, S., Smith, R. and Schumacher, J. (2001) Endodontic therapy for periapical infection of the cheek teeth a study of 19 cases. In: *Proceedings of the 10th Annual Conference of the European College of Veterinary Surgeons*, Velbert. pp 216-218.

Butson R.J., Robinson, J., Schramme, M.C. and May, S.A. (1997) Endodontic therapy for periapical infection in 10 equine cheek teeth: preliminary results. In: *Proceedings of the World Veterinary Dental Congress*, Birmingham. pp 143-145.

Dixon, P.M. (1993) Equine dental disease: a neglected field of study. *Equine vet. J.* **5**, 317-353.

Dixon, P.M. (1997) Dental extraction and endodontic techniques in horses. *Comp. cont. Educ. pract. Vet.* **19**, 628-637.

Dixon, P.M., Tremaine, W.H., McCann, J., Kuhns, L., Hawe, C., Pickles, K., McGorum, B.C., Railton, D.I. and Brammer, S. (2000) Equine dental disease: a long term study of 400 cases. Part 4: Apical infections of cheek teeth. *Equine vet. J.* **32**, 182-194.

Easley, J. (1999) Equine tooth removal. In: *Equine Dentistry*, Ed: G.J. Baker and J. Easley, W.B. Saunders Co., Philadelphia. pp 220-249.

Evans, L.H., Tate, L.P. and LaDow, C.S. (1981) Extraction of the equine 4th upper premolar and 1st and 2nd upper molars through a lateral buccotomy. *Proc. Am. Ass. equine Practnrs.* **27**, 299-302.

Gibbs, C. and Lane, J.G. (1987) Radiographic examination of the facial nasal and paranasal sinus regions of the horse, Part II: Radiological interpretation. *Equine vet. J.* **19**, 474-482.

Guard, W.F. (Ed.) (1951) Equine operations. In: *Surgical Principles and Techniques*, Columbus, Ohio. pp 78-89.

Lane, J.G. (1987) Equine dental extraction: repulsion vs. lateral buccotomy, techniques and results. In: *Proceedings of the World Veterinary Dental Congress*, Birmingham. pp 135-138.

Lane, J.G. (1994) A review of dental disorders of the horse, their treatment and possible fresh approaches to management. *Equine vet. Educ.* **6**, 13-21.

Merillat, L.A. (Ed.) (1906) Tooth removal. In: *Equine Dentistry and Diseases of the Mouth: Veterinary Surgery*, Vol. 1, Alex Eber, Chicago.

O'Connor, J.J. (Ed.) (1942) Operations. In: *Dollar's Veterinary Surgery*, 3rd edn., Baillere, Tindall and Cox, London. pp 250-261.

Prichard, M.A., Hackett, R.P. and Erb, H.N. (1992) Long term outcome of tooth repulsion in horses: a retrospective study of 61 cases. *Vet. Surg.* **21**, 145-149.

Ramzan, P.H.L. (2002) The need for chemical restraint while performing routine dental procedures using a full-mouth speculum: a retrospective study of 581 examinations. *Equine vet. Educ.* **14**, 30-32.

Scrutchfield, L., Schumacher, J. and Martin, T. (1996) Correction of abnormalities of the cheek teeth. *Proc. Am. Ass. equine Practnrs.* **42**, 11-21.

Tremaine, W.H. (1987) Oral extraction of equine cheek teeth: a Victorian technique revisited. In: *Proceedings of the World Veterinary Dental Congress*, Birmingham. pp 139-143.

Tremaine, W.H. (2000) Equine dentistry: dental radiography. *UK Vet.* **5**, 8-11.

Weller, R., Livesey, L., Maierl, J., Nuss, K., Bowen, I.M., Cauvin, E.R.J., Weaver, M., Schumacher, J. and May, S.A. (2001) Comparison of radiography and scintigraphy in the diagnosis of dental disorders in the horse. *Equine vet. J.* **33**, 49-58.