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Introduction

Establishing a scientific basis for equine clinical dentistry

This issue of *The Veterinary Journal* provides a unique collection of original papers on equid dentistry that will be of fundamental value to equine clinicians and researchers and will be an important literary resource for all interested in this rapidly growing subject. We are particularly indebted to Professor Padraic Dixon of the University of Edinburgh for editing this Special Issue and to *The Veterinary Journal* for publishing it.

Merillatt (1906) commented that '*the principal objective of dentistry is to promote the general health (of the horse) by improving mastication and by relieving pain*'. Most equine clinicians would agree that the current goal of dentistry remains the same. Merillatt's text, published in 1906, described how to float enamel points, manage deciduous teeth, and extract terminally diseased teeth. With the exception of the outstanding clinical work of Becker and colleagues some 40 years later (Becker, 1962), the standard of equine dental care saw minimal change through most of the 20th century, with many of the procedures described by Merillatt, such as wolf tooth extraction, canine teeth reductions and bit seat application, still commonly practiced without scientific validation of their merit.

Ironically, the limited literature investigating the relationship between floating and mastication or work performance fails to show any clinically significant correlation (Carmalt et al., 2004a, 2006). While we know horses perceive pain sensation through the dental nerves, dental pain, which is the most common presenting complaint in human dentistry, is not clinically measurable in the horse (Brunson et al., 1987). Exposure of dentine and dentinal processes to the oral environment would cause great pain in other species, yet such exposure occurs on the occlusal surfaces of equine teeth (Kilic et al., 1997) without apparent pain or infection of the underlying pulp via the open dentinal tubules – and this is just one example of many fundamental questions to be answered in equine dentistry. Nevertheless, the work of Anna Tell et al. (2008), published in this Special Issue, conclusively shows that riding horses in a bit and bridle can cause buccal ulceration, which is very likely to cause pain.

Veterinary dentistry began with (and was once synonymous with) equine dentistry, as the horse was the foremost domesticated animal treated by veterinarians in past centuries. Currently, however, equine dental practice lags behind those of other companion animals by approximately 20 years. Several reasons for the delayed development of equine dentistry have been suggested, including the paucity of basic research and even of clinical case reports (Dixon, 1993), the lack of formal dental education (Schumacher, 2001), limitations on early diagnosis of dental disease due to difficulties in clinically examining and imaging the large equine head, and the lack of translational application of human dental surgical techniques to equine dental disease (Pascoe, 2006).

Interestingly, the current growing pains of equine practitioners are similar to those experienced by small animal dentists in the past. In an editorial in the *Journal of Veterinary Dentistry* aptly termed '*All saddled up, but where are we headed?*' Harvey (1997) commented '*To those of us in small animal dentistry, this is a familiar story – recognition of the clinical need by practitioners, lack of interest in the schools, and the sterling efforts by several individuals to elevate their own knowledge followed by a willingness to share their experiences and hard-won expertise with fellow practitioners*'.

However, the need for formal equine dental education has at last been recognized and dental training opportunities for veterinarians are now available through multiple outlets. Many national and international equine and veterinary dental associations now organize lectures and practical classes. For example, in 2006 the American Association of Equine Practitioners and the British Equine Veterinary Association held a joint equine dental conference with 49 papers presented by international speakers, a feat that would have been impossible 10 years earlier (see 'Focus on Dentistry'; http://www.ivis.org).

The current renaissance of equine dentistry began in the mid-1990s when Paddy Dixon recognized the need for species-specific, basic research (Dixon, 1993). His team at Edinburgh University has since made the most significant contribution to the body of equine dental knowledge to date, by publishing multiple studies including morphologically describing equine dental tissues in health and disease.

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Some of the most recent studies of this group describe the dentition of the donkey, which shows minimal differences between the teeth of the two equid species (du Toit et al., 2008a), and provides conclusive evidence that dental disease is associated with colic and weight loss (du Toit et al., 2008b).

Also from the Edinburgh group and published in this issue is a detailed pathological study of dental caries and occlusal pulpar exposure in donkeys (du Toit et al., 2008c), and this work is equally applicable to equine teeth. Then there is a series of five fundamental studies on probably the most significant equine dental disease (cheek teeth apical infections) presented by Dacre et al. (2008a,b,c,d,this issue), and Shaw et al. (2008) that initially reclassifies and quantifies equine dentine in normal equine teeth and quantifies dentine in infected cheek teeth. Two of the papers explore the multiple aetiologies of cheek teeth apical infections and describe the gross and histological changes present in these infected teeth (Dacre et al., 2008c,d).

Researchers at the University of Ghent added to the body of knowledge by publishing several studies describing normal equine dentine (see, for example, Muylle et al., 2000). Workers at the University of Hannover have published descriptive studies on the equine periodontium (Masset et al., 2006; Staszyk and Gasse, 2007; Warhonowicz et al., 2006) and, in this issue, they report the first significant pathological study on the enigmatic odontoclastic incisor/canine syndrome of horses (Staszyk et al., 2008). The Ghent team published the first studies on equine alveolar bone grafting and the use of alveolar prostheses (Vlaminck et al., 2006) to prevent post-extraction dental drift, a topic further explored by Townsend et al. (2008) in this issue.

The first decade of the 21st century has been marked by exponential changes in equine dental practice. While floating teeth ('occlusal equilibration') remains the primary prophylactic procedure, and exodontia is a necessary salvage procedure in many dental cases, the scope of equine care has expanded to include all dental disciplines (endodontics, orthodontics, periodontics and restorative dentistry). Although these disciplines are currently being practiced, formal case reporting remains limited, documentation of long-term case follow-up is essentially lacking, and controlled studies to validate the merit of most of these advanced dental procedures in horses are totally absent. Klugh et al. (2001) first described the restoration of infundibular cavities, and numerous practitioners have performed this with anecdotal success; however, the bonding of restorative materials to equine dental tissues has not been documented, nor has the bonding to cementum in any species been investigated. This latter research is critical for equine dentistry since cementum is a peripheral *structural* tissue, which is currently being stripped from teeth to provide an enamel bonding surface. Likewise the great depth, variable width, and complex anatomical shape of equine cheek teeth infundibula, with the frequent presence of damaged or absent infundibular cementum up to 7 cm beneath the occlusal surface (Fitzgibbons, 2007) needs to be addressed when attempting to restore such lesions occlusally within the limited confines of the equine oral cavity.

Limited success continues to be reported with equine endodontic therapy performed from the apical aspect of the tooth, including the most comprehensive account to date of this procedure by Simhofer et al. (2008a), published in this issue. Reasons for failure include the complexity and lack of knowledge of equine endodontic anatomy, technique sensitivity and poor adaptation of human endodontic instruments and materials to the complex equine endodontic system. The studies of Dacre et al. (2008c,d,this issue) showed the presence of clinically unrecognized periodontal disease, fissure fractures and pulpar exposures in extracted, infected cheek teeth that, if clinically detected, may have influenced the treatment protocol. The technique of oral endoscopy as described by Simhofer et al. (2008b) should help detect such subtle lesions.

Additionally, some of the apically infected cheek teeth described by Dacre and colleagues (Dacre et al., 2008c,d), had such extensive changes to their calcified dental tissues that they would have been poor candidates for endodontic treatment. The detection of such dental changes by modern imaging techniques should be another future priority. Traditionally, endodontic therapy has been reserved for mature horses; however, apexification of an immature permanent incisor has been recently reported (Baratt, 2008). The use of mineral trioxide aggregate (MTA), the most popular endodontic filling material in human dentistry, has been proposed as a retrograde filling material in a horse, but the case report lacks long-term follow-up (Earley, 2006). MTA is of particular interest for equine dentistry because of its properties, which includes its ability to be used in a wet environment and the induction of cementogenesis. Steenkamp et al. (2005) have published the only in vitro study reporting the effective apical sealing of equine cheek teeth.

Interceptive orthodontic therapy in adolescent horses, in the form of deciduous teeth management, is well described, but like many other aspects of equine dentistry, the subject of equine orthodontics has received no critical review. The description of orthodontic treatments in the literature has been limited to the correction of Class II and Class III malocclusions using acrylic bite plates with and without the application of tension bands (DeBowes and Gaughan, 1998; Easley, 1999; Klugh, 2004). However, the first case report describing the corrective orthodontic treatment of an equine cheek tooth malocclusion was reported by Galloway (2008).

Periodontal disease is the primary cause of tooth loss in mammals and was described in the horse by Aristotle around 333BCE (Carmalt, 2007). Becker (1962) described a categorization system for equine periodontal disease (based on oral examination findings), which is still widely used today. Since reattachment of the periodontium was considered impossible, direct periodontal treatment during the second half of the 20th century was limited to irrigation