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History of Veterinary Dentistry, Including Development of Oral and Dental Treatment of Wild and Zoo, Safari Park and Refuge Animals

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This review is limited to a narrow definition of dentistry – conditions affecting the teeth, periodontium and jaws, and treatment of these structures. Mention of the major infectious oral diseases that affect wild, as well as domestic herbivores, such as viral stomatitis for example, are not included.

Veterinary dental history can be considered as having two major periods, the first in which the horse was the focus of most attention, because of its importance for transportation, mechanical power, military use and sport. The jaws and teeth were important because bits are used to control speed and direction of motion in horses. The internal combustion engine was invented in the mid-1850s; by the early 1990s, this form of transportation and mechanical power was rapidly displacing the horse and, as a result, equine dentistry no longer has the critical societal importance it once had.

The second period is ongoing, and is largely based on application of human dental procedures to pet domestic animals. As experience with these procedures, initially in dogs, grew, they started to be applied to non-domesticated species by a pioneering group of human dentists and veterinarians. Experience with dental treatment of food animals is largely limited to management of tooth loss in sheep.

We only have a very incomplete glimpse of what was known about animal dentistry in the ancient world, because much of the records have been lost. The fire in the largest library of the ancient world, at Alexandria in 48 BCE, was catastrophic – 700 000 volumes were lost.

The ancient Greeks produced several important veterinary manuscripts, such as "The Veterinary Art, Inspection of Horses," by Simon of Athens (430 BCE), which includes an accurate description of eruption times and aging of horses by examination of the teeth. Aristotle's "History of Animals'" (333 BCE) also includes a section on aging by teeth of horses, and comments on periodontal diseases in horses.

The Roman Empire produced some practical veterinary material, though much of it was copied from Greek sources. Around 400 CE, Chiron wrote a series of books on animals; Book VI includes material on tumors of the jaw, diseases of the teeth and management of fractured jaws, and Book VIII includes a description of the dentition. "The Veterinary Art" by Vegetius (450–500 CE) is the major Roman veterinary contribution; it describes use of splints for managing broken jaws, and aging of horses by teeth; this manuscript was translated and printed as a book one thousand years later, in 1528 – one of the first veterinary books printed.

Written c550–580 CE, originally in Sanskrit, the work of Ippocras was translated into Greek or Arabic in the ninth century, then from Arabic to Latin – it is now known to exist only as a fifteenth-century manuscript in Latin; it includes a section on determining the age of the horse by examining the teeth, and vices and bit injuries, also an operation for "chesel," which is extraction or shortening of the tushes (canines) and corner incisors to accommodate the bit.

With the degeneration of the Greek and Roman empires, the focus of learning shifted eastward to the Byzantine Empire. In about 950 CE, the "*Hippiatrika*" was written by order of Emperor Constantine VII. This tome contained all Greek and Latin veterinary manuscripts in Constantinople, collected and arranged; it includes a section on Dentition. It was translated by Ruellius from Greek to Latin and printed in 1530 in Paris.

The fascination of Arabs with horses was recognized in some important manuscripts; one, written about 1100 CE by Ibn-al-Awan in Spain, includes a section on dentition. Around 1200 CE, Abou Bekr produced "*The Naceri*" in Egypt; Book 11 includes a section on dentition and dental operations.

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Beyond the translation of ancient sources, there was very little real progress for about one thousand years, until, starting in the thirteenth century in Italy, ancient manuscripts translated into Italian also began to include personal observations of the translator. Ruffus wrote "Equine Medicine" in 1250, and Rusius wrote "Hippiatria" about 70 years later; the latter includes sections on dentition and descriptions of lampas, cutting the lip to accommodate the bit, and an "operation on the teeth to improve the temper" (extraction of lower canines and corner incisors). Later, came the equine anatomical masterpieces of Leonardo da Vinci and Ruini. Though these were important contributions to the veterinary knowledge base, there was little that was new in the field of clinical veterinary dentistry.

Northern Europe was largely an intellectual backwater regarding veterinary medicine until late in the eighteenth century. Available written materials include an early manuscript written in Britain in about 1000 CE entitled "The Medicine of Quadrupeds," which is largely a compilation from earlier Roman manuscripts. As an example of what now seems ridiculous, from the 1723 edition of a book originally published in 1610: "*A horse may have pain in his teeth through diverse occasions, as partly by the descent of gross humors from the head down to the teeth and gums*."

Dental extractions in horses have been performed and described for many centuries. Initially, this was performed by striking accessible teeth, such as wolf teeth, directly. "*With the horse's head tied up high, and his mouth opened wide, take a carpenter's gouge, place the edge at the foot of the wolf tooth, turn the hollow side downwards, holding your hand steady so that the tool may not swerve or slip, then strike the head of the tool a good stroke wherein you may loosen the tooth and bend it inwards, then wrench the tooth out with the hollow side of the tool. Then fill up the empty hole with salt finely brayed*." Trephining was developed as a means of opening the frontal and maxillary sinuses for treatment of nasal diseases caused by glanders or sometimes by dental disease by Lafosse in 1749.

Until the nineteenth century, dental procedures in animals largely were performed by the owner of the animal, or by horse leechers, farriers and other often illiterate practitioners. "Learning" was handed down from generation to generation, mistakes, superstition, and all. Though the invention of printing in the fifteenth century permitted major advances in the distribution of material, it did not necessarily improve the quality of the information. With few exceptions, there is a distinct lack of critical, observant minds evident in the "veterinary" books of the sixteenth, seventeenth and first half of the eighteenth centuries.

By the end of the nineteenth century, though the horse was losing its critical utility in the human world, equine dentistry was sufficiently advanced that "Equine Dental Colleges" were established; these were not associated with veterinary schools.

Two factors that did bring considerable subsequent progress to equine dentistry were development of mechanical gags and of powered dental rasps for "floating teeth." These features together resulted in significantly improved ability to manage occlusal abnormalities.

We now accept without question that anesthesia is essential for veterinary dental procedures; however, safe, effective anesthetics are a relatively recent addition to the veterinary armamentarium. Major advances were use of: IV opium in dogs in 1665; nitrous oxide gas in cats in 1779; ether in animals in 1847; barbiturates in 1902; flexible endotracheal tube in1914; and pentobarbital and pentothal in 1931–1934.

Small animal dentistry got off to a slow start compared with horses. The very early descriptions of dental or oral surgical procedures in dogs sound barbaric (particularly given the absence of practical anesthetic techniques). The indications were sometimes based on superstition rather than medical reality, such as excision of the lyssa (the fibromuscular tube that supports the rostral end of the tongue) to prevent rabies in the dog, described by Pliny (50 CE). On this topic, six hundred years later, Samuel Johnson (author of the first English dictionary) says of the "worm" of the dog's tongue, "*it is a substance, nobody knows what, extracted nobody knows why*"! There were occasional reports of "advanced" procedures, such as placement of dentures in dogs, in the late nineteenth century, however, significant growth in recognition of and means of treating oral and dental conditions in companion animals did not occur until the latter part of the twentieth century.

The need for attention to oral health in dogs and cats was, in part, precipitated by the major change in pet diets from about 1930 onwards; when domesticated dogs and cats are required to hunt for their own food, or cadaver material was their only food provided, the diet provided significant chewing activity that largely kept severe periodontal disease at bay during the life-time of the animal. When a defined nutritional profile convenience diet is fed, there is reduced chewing activity and greater build-up of dental plaque and calculus, such that periodontal disease became the most common clinical abnormality observed in dogs and cats by the end of the twentieth century. When owners provide hard materials such as cleaned processed bone, antlers or cattle hooves, or hard nylon toys, in an attempt to provide chewing activity, the risk of fracture of teeth increases. In addition, dogs and cats were living longer, because major viral diseases such as distemper and parvovirus infection in dogs and panleucopenia in cats were prevented by vaccination, thus enhancing the likelihood of development of chronically progressive diseases

such as periodontal disease. The result of these changes is that by mid-twentieth century, the increasing prevalence and severity of oral and dental diseases in dogs and cats was recognized, primarily among small animal practitioners rather than by those in academia. The impact of use of convenience foods on the oral and dental health of non-domesticated animals in zoological collections is considerable, because the mouths cannot be examined frequently, and brushing or wiping the surfaces of the teeth as an oral hygiene measure is not possible. This is true not just of carnivores, but also of herbivores, where, for example, chopped hay may provide far less chewing activity than full pasture grazing. Rather than grinding meat and mixing in additional ingredients as required, as was normal previously, most zoos now feed diets that match the form of the natural diet for that species, and provide the essential micronutrients by, e.g. stuffing them into large raw meat pieces for carnivores; this combination provides the tearing and chewing activity necessary to prevent rapid accumulation of dental plaque and calculus.

Another source of new veterinary dental knowledge from the mid-part of the twentieth century onward has been use of beagle dogs as a favored animal model for research in dental school laboratories, which has significantly increased the canine periodontal knowledge base.

One of the important sources of training for the initial core group of "dentally aware" small animal practitioners was human dental practitioners who were invited to consult on canine and feline dental patients. A few human dentists became critical players in veterinary dental continuing education programs, and some (such as Drs. Peter Emily, Peter Kertesz, Mark Tholen, Carl Tinkelman, John Scheels and Boyd Welsch) were important early contributors as volunteer dental consultants to zoos and other non-domesticated animal collections. As companion animal and particularly zoo and wildlife dentistry developed, the limitations of human dental instruments became evident, particularly in endodontics because of the grossly insufficient length of human endodontic instruments when treating a canine tooth in a large dog or a tiger, in which the root is typically several times as long as the longest human tooth root.

As veterinary dentistry became a standard part of veterinary medicine in the latter quarter of the twentieth century, individual veterinarians began to devote all of their professional effort to dentistry, and began meeting to discuss topics of mutual interest. This led to the formation of the American Veterinary Dental Society in 1976, and to recognition of dentistry as an area of veterinary specialization starting in 1987. The leaders of this group of board-certified veterinary dentists included several who, like their dental colleagues mentioned above, volunteered their time as consultants to zoos; early examples were: Drs. Chuck Williams (National Zoo, Washington DC), Ben Colmery (Detroit Zoo), Bob Wiggs (Dallas Zoo), Don Ross (Houston).

A critical step in the development of zoo and wildlife dentistry has been the willingness of these, and later individuals, to share their experience; there have been two Zoo and Wildlife Dentistry conferences, with abstracts of one of these meetings published in the Journal of Veterinary Dentistry.

As the content of this book will demonstrate, there are very unique challenges associated with zoo and wildlife dentistry; sharing information about successes and failures is critical to minimize the risk of repetition of failure during the learning curve of individual veterinary dentists. This book is designed to provide a strong collective foundation in that regard.

In 2017, the American Veterinary Dental College recognized the increasing interest in zoo and wildlife dentistry by establishing an AVDC Zoo and Wildlife Dentistry Certificate program. A Delphi process and examination resulted in recognition of 15 founding AVDC-ZWD Certificate holders. They are: Drs. Kris Bannon, Jan Bellows, David Clarke, Stephen Coles, Edward Eisner, Roberto Fecchio, Nadine Fiani, Barron Hall, Steven Holmstrom, Loic Legendre, Michael Lowder, Clarence Sitzman, Gerhard Steenkamp, Frank Verstraete and Douglas Winter. This process included developing a list of publications on zoo and wildlife dentistry and related topics, which the ZWD Certificate Organizing Committee plans to make available. Though AVDC-ZWD certificate holder status is limited to veterinarians, a list of human dentists who have contributed significantly to the development of zoo and wildlife dentistry is under consideration for recognition for honorary status in the ZWD Certificate program.

This chapter is based on a review of some of the classic histories of veterinary medicine, a recent description of veterinary dental history, a personal collection of veterinary antiquaria accumulated over the last 50 years that includes items dating to the seventeenth century, and personal interactions with the pioneers in zoo and wildlife dentistry. There may be some important sources that I have missed. I would appreciate receiving comments on this chapter, and, in particular, details of any sources that I have not included, or corrections of or different interpretations of material that I have included.