TYPE AND FREQUENCY OF DENTAL CONDITIONS IN DOGS AND DONKEYS IN KENYA

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF REQUIREMENTS FOR THE AWARD OF A MASTER OF SCIENCE DEGREE OF THE UNIVERSITY OF NAIROBI

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university.

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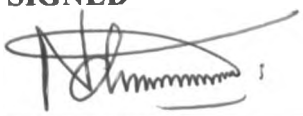

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This thesis has been submitted for examination with our approval as University supervisors.

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DEDICATION

This work is dedicated to my patients and my family especially Sharon for support and patience through it all.

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LIST OF ACRONYMS AND ABBREVIATIONS

ATNESA	Animal Traction Network for Eastern and Southern Africa
DSO	Donkey Sanctuary Overseas
DSWW	Donkey Sanctuary World Wide
FAO	Food and Agriculture Organization of the United Nations
KENDAT	Kenya Network for Dissemination of Agricultural Technologies
KSPCA	Kenya Society for the Protection and Care for Animals
UON	University of Nairobi

ABSTRACT

Type and Frequency of Dental Conditions in Dogs and Donkeys

This study aimed to determine the prevalence, clinical features and interventions for dental conditions affecting dogs and donkeys. Two hundred and thirty five dogs from the University of Nairobi, Small Animal Clinic were used. Dental history was taken, physical and dental examination done and the findings recorded in Modified Triadan charts. Dental conditions were classified into three categories; periodontal, endodontic and miscellaneous.

Dental radiology was also performed in twelve dogs with periodontal disease and oral tumors, under general anaesthesia, using conventional mobile x-ray equipment. Dental radiographs were obtained with **55**kV, **10**mAs and a focal length of **40** cm. The technique was used to assess the alveolar crestal bone, the periodontal ligament, the lamina dura, periapical radiolucency, tooth roots, and other non-odontogenic changes. Dental intervention procedures were then carried out in selected dogs using manual dental instruments and soft tissue surgery techniques.

One thousand, two hundred and eleven donkeys from the KSPCA clinics in Nairobi, Limuru, Kiambu, Bomet, Nyahururu, Maai-Mahiu, Nanyuki, Mweiga and Rumuruti were used in the study. Dental history and findings on physical and dental examination were recorded in Modified Triadan charts. Clinical examination and treatment interventions were done under manual restraint.

Sixty-eight dogs had various dental conditions, indicating a prevalence rate of **28.9%**. Of these cases, the most frequently observed periodontal conditions were; dental plaque (**89.7%**), gingivitis (**76.5%**), halitosis (**69.1%**), and dental calculi (**64.7%**). Periodontitis (**35.1%**), gingival recession (**25.0%**), periodontal pockets (**23.5%**), and mobile teeth (**16.2%**), were less frequently observed. The most common endodontic conditions were pulp exposures (**32.4%**), fractured teeth (**20.6%**), and dental caries (**19.1%**) some of which showed radiographic changes (**17.6%**). Missing teeth due to periodontal disease or lack of eruption (**7.4%**), and dental fistulas (**2.9%**) occurred infrequently. Miscellaneous teeth conditions were malaligned teeth (**7.4%**), retained deciduous teeth (**5.9%**), and supernumerary teeth (**1.5%**). Other signs associated with dental conditions included; regional lymphadenopathy (**8.8%**), soft tissue trauma (**5.9%**), brachygnathism (**5.9%**), alterations in extra oral structures, such as asymmetry (**5.9%**), oral tumors (**2.9%**), and glossitis (**2.9%**). Radiographic diagnoses were made for teeth fractures, periodontal disease, dental abscesses and oral tumors. Dental procedures performed in the dog included; dental scaling, manual polishing, subgingival curettage (root planing), and extractions. Soft tissue surgery involved gingivectomy, restorative cheiloplasty and antidrool cheiloplasty. Oral antisepsis and systemic antibiotic treatment were used adjunctively.

One hundred and forty nine donkeys representing a prevalence of **12.3%** had various dental conditions. The most frequently observed dental conditions were wave mouth (**18.8%**), dental calculi (**12.9%**), enamel caps (**11.8%**) and incisor conditions (**9.4%**) such as retained (persistent) deciduous incisors, abnormal eruption, excessive wear, and fractures. Conditions that occurred in moderate frequency included sharp enamel edges

(**8.8%**), dental calculi with gingivitis (**8.2%**), step mouth (**7.1%**) and hooks on premolars (**7.1%**). The least frequent dental conditions were loose teeth (**4.7%**), discolored teeth (**4.7%**), swelling on mandible (**1.8%**), necrotising stomatitis (**1.8%**), gingival hyperplasia (**1.2%**), traumatic cheilitis (**1.2%**) and maxillary swelling (**0.6%**). Dental rasping was carried out to correct conditions due to abnormal wear such as wave mouth and sharp enamel edges. Extraction was carried out for enamel caps, loose teeth, and shedding incisors. Oral sanitization was done for cases with necrotising stomatitis and traumatic cheilitis.

This study has documented the prevalence, clinical features and interventions for dental conditions in dogs and donkeys. The data is useful in highlighting the nature and frequency of dental conditions encountered in these species. Conventional x-ray equipment was also adapted successfully for dental radiology and proved an invaluable aid in diagnosis of endodontic conditions in dogs. Successful intervention techniques for dental conditions in the two species were also performed. The application of the findings of this study by veterinarians, animal scientists and owners should enhance the health and welfare status of these animals in Kenya.

CHAPTER ONE

1.0 INTRODUCTION AND OBJECTIVES

1.1 INTRODUCTION

The mouth is the initial location of mechanical and chemical digestion of food in animals. In order to maintain optimum health, all the structures of the mouth including the teeth, and associated hard and soft tissue must be in the normal state. Animals require strong teeth that are properly anchored within the upper and lower jaws. Structural abnormalities, metabolic, toxic and infectious disease conditions, trauma, tumors and other conditions that cause pain, may lead to functional disruption of the mouth, and especially the teeth. This impairs effective prehension and initial digestion of food, which subsequently compromises the patient's health (Eisner, 1994).

In developing countries such as Kenya, veterinary dentistry has largely been associated with the perception that only tooth extraction is done as an intervention technique for clinically significant dental conditions in the canine and equine species. Extraction is preferred as it has the benefit of prompt removal of infection with quick relief of pain. In the equine species, this method is surgically invasive due to the use of osteotomy through either the mandible or the maxilla to achieve repulsion of the large teeth. In the dog, surgery may also involve osteotomy especially for the canines. In both species however, it is important to salvage teeth since adjacent teeth support each other. Teeth also help maintain the aesthetic appearance of the patient and are important for mastication. Teeth that have intact periodontal tissues and roots can be salvaged even though they may have damaged vascular and neural supply (Eisner, 1994).

Veterinary dentistry as a specialty has shown the greatest advances in equine and canine practice worldwide. This has been notable in aspects of routine care, clinical and radiological diagnostics, therapeutic interventions, and cutting edge cosmetic procedures such as endodontics and orthoplasty. The dog is an important part of households in Kenya and many owners incur substantial expenses related to its health and welfare. It is an ideal animal for comparative clinical dentistry. On the other hand, the equine species has over time evolved from a working animal to also being considered as a pet. Horses are a status symbol and are used for recreational sports. The donkey, a relation of the horse, was used in this study as it is found in many rural households in developing countries. In Kenya, scientific information on the clinical, radiological and histopathological features of dental conditions occurring in dogs and donkeys is also scant. This is despite the fact that they are likely to be encountered in clinical practice, and may cause significant distress to the general health and welfare of affected animals.

Accurate diagnosis of dental conditions is an important component of veterinary practice. This study was designed to improve the clinical and radiological expertise in veterinary dentistry and to determine the nature of dental conditions affecting dogs and donkeys in Kenya.

1.2 OBJECTIVES

The objectives of this study were to establish the following aspects for dogs and donkeys in Kenya;

1. Identify and characterize dental conditions based on clinical features.
2. Determine the prevalence of dental conditions.
3. Evaluate available interventional techniques for management of dental conditions.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 CANINE DENTISTRY

2.1.1 OVERVIEW OF CANINE DENTISTRY

Dogs are kept as household pets or guard dogs, and constitute a majority of patients in most veterinary practices in the urban areas in Kenya. The dog is an ideal model for comparative studies of biomedical conditions and techniques in other animals and man.

Dental examination is important for accurate diagnosis and timely management of dental conditions. This would prevent relatively benign conditions from predisposing to more severe disease. For example, persistent deciduous teeth lead to gingivitis and periodontitis due to the presence of trapped food, hair and other debris. Persistent deciduous teeth may also cause malocclusions with trauma to soft tissue and palate with ensuing infections (Tutt, 2003).

Conditions affecting the oral cavity may exacerbate pre-existing systemic disease as a result of poor nutrition or pain. Infectious conditions affecting the mouth may cause constant shedding of bacteria into circulation. This may result in the establishment of infection in vulnerable tissues remote to the oral cavity such as heart valves (Bojrab and Tholen, 1990).

Simple techniques of dental care applied by owners at home have been shown to prevent the occurrence of some dental conditions in dogs. Cereal biscuits and rawhide chews effectively remove and prevent the accumulation of supragingival calculus (Lage et al., 1990). Pet toothpaste and toothbrushes prevent the occurrence of dental

calculus, caries and gingivitis in dogs. However, some of the dental conditions seen at veterinary practices comprise surgical conditions or structural anomalies that cannot be prevented at home. This justifies the need for accurate diagnosis and management of dental conditions at veterinary practices with technical expertise and dental facilities.

Optimum dental health is necessary to alleviate pain, maintain adequate nutrition and fluid intake, and prevent complicating secondary infection (Tholen & Hoyt, 1990). This remains the ultimate aim in canine dental surgery.

There are several options for dealing with dental conditions in the dog. The application of these options depends on the dental condition being addressed, availability of diagnostic facilities and dental instruments, and the technical expertise of veterinary professionals. Likely scenarios may involve simple procedures such as dental scaling, to more complex procedures in orthodontics. For example, the repair of mandibular fractures and dental restoration can be done using monocortical bone plating, interdental fixation with acrylic, or with external skeletal fixators (Kern et al., 1995). This is an involving procedure requiring expertise, the correct instruments and surgical materials for success. The small size, ability to tolerate orthodontic devices and the willingness of owners to pay for elaborate surgical interventions makes the dog an ideal species for the development of dental techniques.

Diagnostic radiology is an indispensable tool in clinical dentistry, especially in endodontics (Bellows, 1993). Radiographs enable the assessment of structures that are otherwise not examinable clinically. These include the alveolar bone, lamina dura, periodontal space, and the pulp cavity (Thrall, 2002). Lesions such as caries can be

recognized without radiography. But the full extent of the lesions, and whether pulpal and periapical involvement is present as a consequence, require radiography. Periodontal disease, endodontic disease, caries, resorptive lesions, fractures, bone pathology, and neoplastic conditions all require radiography for a more complete diagnosis, thus allowing optimal planning of treatment (Gorrel, 1998). The correct technique must, however, be applied to ensure confirmatory diagnosis. Specialised techniques such as the bisecting angle technique may then be required to achieve this.

Studies have shown that oral malodor (halitosis), is highly associated with severity of dental plaque, gingivitis, periodontal disease and other infectious conditions (Hennet et al., 1998). Thus a history of halitosis would most likely lead to a diagnosis of a dental condition warranting either medical or surgical intervention. Other signs commonly associated with dental conditions in the dog include; head shaking, hypersialism, pain on handling the face, foul smell from the nasal cavities, reluctance to feed and holding of the head to one side. Others are; dull coat, loss of body condition, swellings on the face, epistaxis, draining abscesses from the jaw or maxilla and irritability. Common dental conditions such as plaque and calculi predispose to other serious conditions such as periodontitis that may lead to loss of teeth.

Dental plaque is composed of bacteria within a matrix of salivary glycoproteins and extracellular polysaccharides. The most obvious gingival alteration associated with the presence of plaque is hyperemia of the free gingival margin and increased depth of the gingival sulcus on probing with a periodontal probe or a shepherd's crook dental explorer.

Calculus is dead calcified plaque. Calcification starts at the coronal aspects of the tooth and extends apically. Mineralization occurs by precipitation of calcium phosphate and calcium carbonate within the organic matrix of the plaque. Bacteria contribute to propagation of dental plaque, gingivitis and periodontal disease (Emily & Penman, 1994).

Exposure of the pulp chamber exposes it to bacteria that invade the root canal of the tooth. The pulp gets inflamed and eventually necrotises. Apically a cyst, granuloma or abscess may form seen radiographically as a halo of radiolucency around the tip of the root. Abscesses may present clinically as fluctuant swellings on gums apical to the affected tooth (gum boils), or as draining fistulas. Pulp necrotising with an intact root canal causes staining of the crown due to infiltration of breakdown products through the dentine tubules. The stain may be pink to purple in color (Emily & Penman, 1994).

Additional signs of endodontic conditions include; general ill thrift, premature aging, disinterest in play, infertility and aggression (Emily & Penman, 1994).

Dental caries are uncommon in dogs. By the time they are clinically discernible, the damage has progressed through the enamel and dentine and encroached on the pulp (Emily & Penman, 1994, Kyllar & Witter, 2005). This condition accounts for up to 10% of teeth loss in dogs (Bojrab & Tholen, 1990). Dental caries are bacteria induced decalcification and dissolution of the organic portion of the tooth. Root surfaces of teeth affected by periodontitis are more susceptible since they lack enamel. The dentine with less inorganic components breaks down faster than the enamel and the lesion mushrooms (Bojrab & Tholen, 1990).

Fistulas associated with the teeth occur as infection localizes and eventually forms drainage to the exterior. Periapical abscesses often drain within the oral cavity (gum boil) or on the skin as with infection of the upper carnassial. Conversely, fistulous tracts only develop in about 10% of patients with periapical abscesses (Bojrab & Tholen, 1990).

2.1.2 DENTAL ANATOMY IN THE DOG

Calcification of all deciduous teeth is initiated by day 55 of gestation and completed by day 20 postpartum for the crowns and day 45 postpartum for the roots. Of the permanent teeth, only the lower first premolar calcifies by day 55 prenatally. The dental laminar first appears at the 25th day of gestation and the right and left laminae join at the midline by day 30 to form a continuous dental arch. The vestibular lamina that separates the gums from the lips and cheeks occurs as an invagination lateral to the dental lamina. Differentiation of the deciduous enamel organ begins by day 30 of gestation and progresses in the following sequence; bud, early cap, cap, advanced cap, early bell and advanced bell stages (Evans, 1993).

Tooth eruption involves root growth, bone growth, pulpal proliferation, tissue pressure and periodontal traction. Deciduous teeth rise within the jaws after the crown is formed to give room for development of the roots. The movement of the crown is facilitated by the loosening of the connective tissue of the dental follicle and the gum and by the presence of remnants of the dental lamina that defines the line of passage. If remnants of the dental lamina are large and cystic, they may alter the path of migration and result in misalignments. The retention of an epithelial covering over the un-erupted crown ensures that there is no breach of continuity when the tooth breaks

through to the surface since the remnant of the enamel organ fuses with the epithelium of the gum around the tooth (Dyce et al., 1987).

Permanent teeth develop in bony crypts deep to the roots of corresponding deciduous teeth. The movement by bone remodeling leads to the placement of the permanent tooth below the root of the deciduous tooth leading to root resorption. The attachment of the deciduous tooth is loosened, increasing mobility and eventual shedding during mastication. Proper eruption of permanent teeth depends on the deciduous teeth holding the alveolar space for them. Premature loss can lead to filling of the alveolus with bone leading to impaired eruption for the permanent teeth (Dyce et al., 1987).

The dental unit consists of the teeth, supporting tissues, gingiva, dental alveolae and the periodontal ligament. The last three components comprise the periodontium. The tooth is a mass of dentin surrounding pulpal tissue, the crown of which is covered by enamel and the root by cementum. The enamel is mineralized inorganic substance, mainly hydroxyapatite, serving to protect the pulp and underlying dentine. It is impermeable except when cracked or defective. The dentine is hydroxyapatite with a 25% organic collagen content and contains nerve fibers that are stimulated if the overlying enamel is defective or cracked. The dental pulp is connective tissue occupying the root canal from which dentine develops and also provides nutrition and nervous supply to the tooth. This pulp is continuous with the periodontal ligament at the apical pole of the tooth. The cementum is a thin bone like structure that covers the root surface and it is to this structure that the periodontal ligament is attached via collagenous Sharpey's fibers. Teeth roots are embedded in bone sockets in the mandible and the maxilla called alveoli. The alveolar bone consists of cancellous

bone covered by cortical bone to which the periodontal ligament attaches (Dyce et al., 1987, Harvey et al., 1983).

The gingiva is keratinised squamous epithelium that covers the bone to which the teeth are embedded. The gingiva is attached both to this bone and to the tooth. Underlying the gingival epithelium is non-elastic connective tissue that attaches to the alveolar bone periosteum (Harvey et al., 1983).

Dentition is adapted for the feeding habits of the dog, which is carnivorous. The incisors are small, peg like and are crowded in the rostral part of each jaw. On eruption each upper incisor has a trilobed crown with a labial cutting edge. The lower incisors are bilobed. These features are lost as wearing reduces the tooth to a simple prismatic peg. In the dog, incisors are used for nibbling and grooming rarely for dividing food as in other species. The canine teeth are well developed, large curved and laterally compressed, used for holding food and in aggression (Dyce et al., 1987). The root has a wide diameter that is greater than the periphery of the alveolus at the gum margin. This makes it dangerous to apply direct traction to extract the tooth. The alveolar margin must be enlarged sufficiently using a dental elevator or the lateral alveolar wall must be removed to permit extraction of the tooth from its socket (Boyd et al., 2001).

Premolars and molars constitute the cheek teeth. The premolars form an irregular, closely spaced series of increasing size and complexity. The cusps occlude in a discontinuous serrated cutting edge for rapid cutting or holding of food (Dyce et al., 1987). The upper last premolar and the lower first molar are the carnassial or

sectorial teeth. They are adapted for severing large pieces of food with a shearing, scissor-like action. The upper carnassial has a trifid root system that makes extraction difficult without splitting the tooth first (Boyd et al., 2001). The more caudal molars are more useful in crushing due to their broader masticatory and occlusion surfaces but also have cutting potential. Their dual function is referred to as tuberculosectorial. Dental anatomy in the dog is represented in Figure 1 and Figure 2.

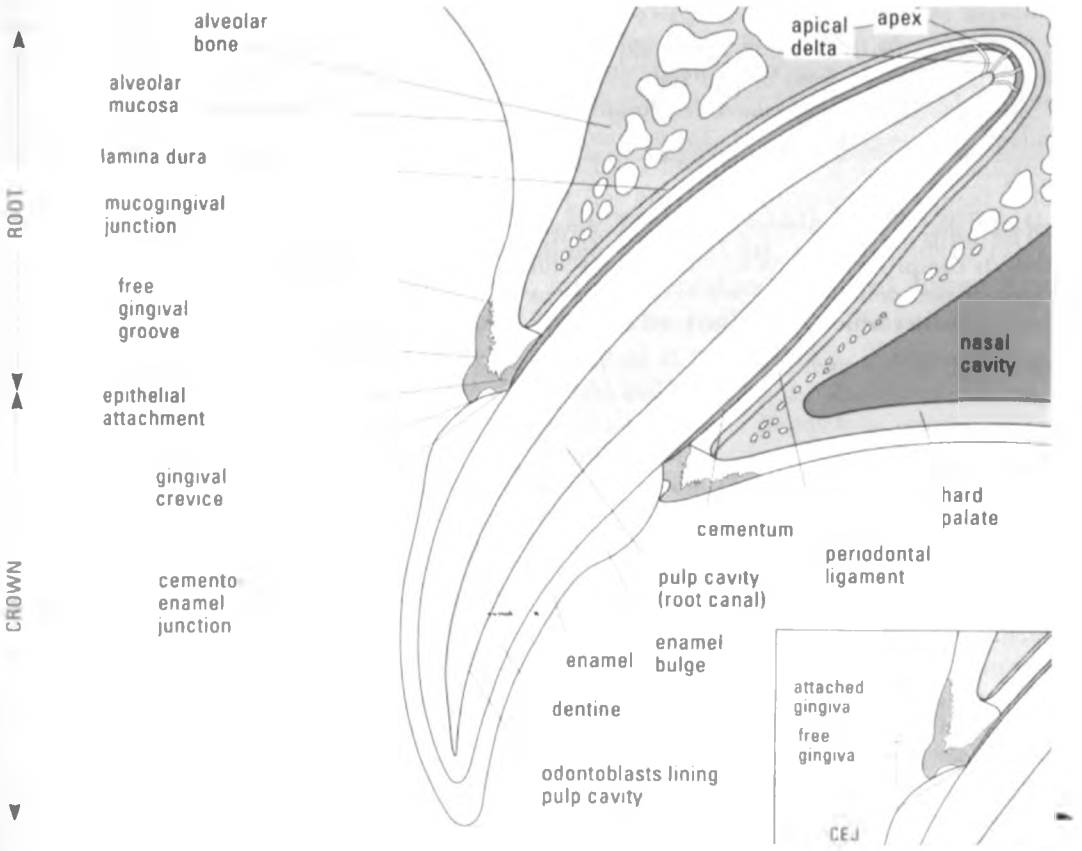


Figure 1; Schematic section through the upper canine in an adult dog. (Handbook of Small Animal Dentistry-Emily, P. & Penman, S., 1994).

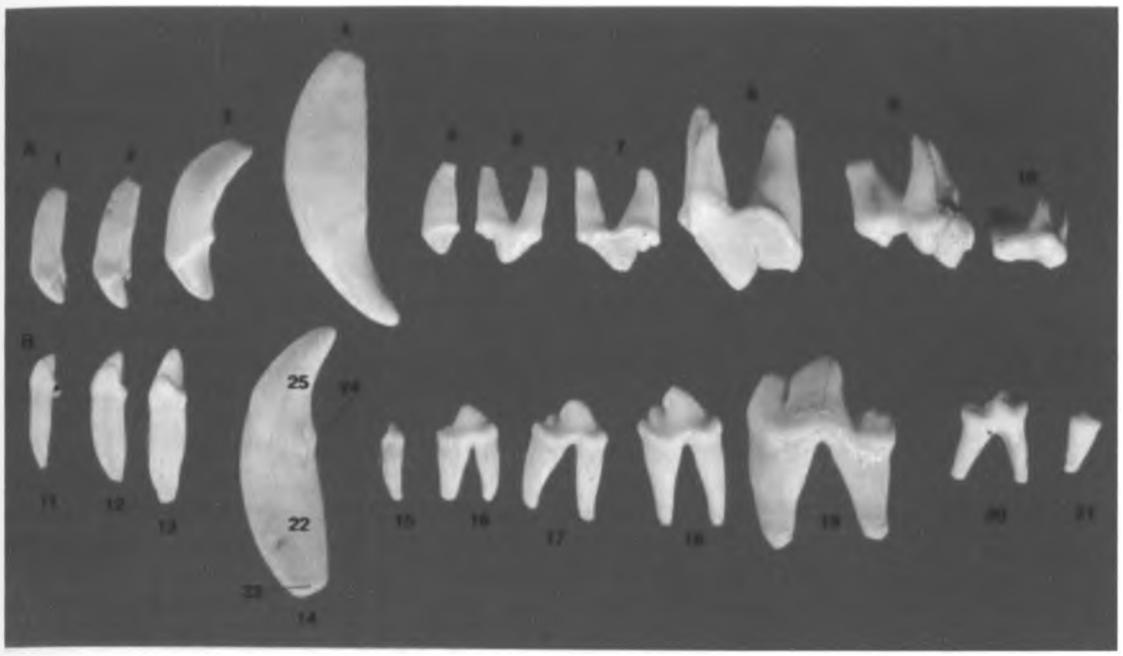


Figure 2; Dental anatomy of an adult dog. Upper incisors(1,2,3), upper canine (4), upper premolars (5,6,7) upper last premolar/carnassial (8), upper molars (9,10), lower incisors (11,12,13), lower canine (14), lower premolars (15,16,17,18), lower first molar/carnassial (19) and lower molars (20,21). The root, apex, cemento-enamel junction and crown are indicated by 22, 23, 24, and 25 respectively. (Color Atlas of Clinical Anatomy of the Dog and Cat – Boyd, J.S. 2001)

2.1.3 CLINICAL DENTAL CONDITIONS IN DOGS

Several conditions affecting the teeth and associated structures in the dog are described below.

2.1.3.1 RETAINED DECIDUOUS TEETH

For the deciduous tooth to be shed, the tooth bud of the permanent tooth must be positioned directly below the roots of the deciduous tooth. This leads to the resorption of the roots with subsequent replacement of the deciduous tooth. Failure of this leads to the retention of the deciduous tooth. This commonly occurs with the incisors being retained rostrally and the canines being retained laterally. The retained tooth may cause displacement of the permanent tooth and invariably leads to the accumulation of food debris with resultant dental plaque and soft tissue inflammation. Extraction of the retained deciduous tooth is indicated, taking care not to use the erupting permanent tooth for leverage to avoid damage (Bojrab & Tholen, 1990, Emily & Penman, 1994, Harvey et al., 1983).

2.1.3.2 SUPERNUMERARY TEETH

The presence of additional permanent teeth results in crowding and rotation of teeth. The extra teeth may also trap food debris leading to inflammation of soft tissue and thus should be extracted (Bojrab & Tholen, 1990, Emily & Penman, 1994, Harvey et al., 1983).

2.1.3.3 IMPACTED TEETH

Impaction occurs when teeth do not erupt beyond the alveolar bone and overlying soft tissue. The condition is rare in dogs and extraction is indicated with partial impaction to prevent the development of periodontal disease. Early diagnosis by radiography

followed by surgical removal of overlying tissue may lead to normal growth (Harvey et al., 1983).

2.1.3.4 ENAMEL HYPOPLASIA

Enamel hypoplasia occurs due to disruption of enamel formation in-utero or shortly after birth, appearing as white opaque or brown stained irregularities or depressions on the surface of the enamel. This may lead to erosion and formation of caries. Canine distemper has been associated with its occurrence (Bojrab & Tholen, 1990, Emily & Penman, 1994, Harvey et al., 1983, Ettinger & Feldman,1995).

2.1.3.5 MALOCCLUSION

Malocclusion is the deviation from the normal orientation of the dental arcades due to misalignment of teeth. The causes include genetic defects such as overshot jaw, retained deciduous teeth, ectopic eruption of permanent teeth, trauma to teeth and jaws during development and poor management of orthopedic injury. Malocclusion affects the aesthetics of an animal and predisposes to periodontal disease due to accumulation of plaque between overcrowded teeth. Misaligned teeth impinging on soft tissues can be shaped into conformity using a power tool, or extracted to avoid further injury (Harvey et al., 1983). Orthodontic therapy is also popular in tipping teeth back into normal alignment using orthodontic braces (Bojrab & Tholen, 1990, Emily & Penman, 1994, Harvey et al., 1983, Ettinger & Feldman, 1995).

2.1.3.6 DENTAL CARIES

Carbohydrate fermentation to release acids by bacteria leads to the destruction of tooth structures (Harvey et al., 1983). This affects the crown or exposed tooth root

cementum. This is common in the cheek teeth, molars and premolars. The condition is not common in dogs due to the anatomy of their teeth that do not have naturally occurring pits and fissures to permit accumulation of food. The diet is not predominantly carbohydrate and the pH of dog saliva is alkaline thus neutralizing any oral acids. The incidence of dental caries is high in patients fed on soft food high in fermentable carbohydrate. Accumulation of dental plaque in the gingival sulcus leads to the development of caries in the cementum and underlying dentine. The lesions are seen as dark brown pits, easily picked with a dental explorer. Since the enamel and cementum cannot repair themselves, restoration is indicated with an appropriate filling material. Persistent deep caries cause infection of the pulp with necrosis, abscessation or cyst formation. This requires either endodontic therapy or extraction (Bojrab & Tholen, 1990, Emily & Penman, 1994, Harvey et al., 1983).

2.1.3.7 TRAUMA

Traumatic injuries to teeth in dogs include; fractures, avulsion, resorption, attrition, and malar abscessation. Fractures are caused by sharp external force to the tooth with resultant chipping of the brittle enamel due to its crystalline structure. This may be of no consequence if involving only the enamel. Involvement of the underlying dentine leads to inflammation with reparative dentine being produced to protect the exposed pulp. Extension of the fracture into the pulp cavity may lead to endodontic disease or alveolar abscessation. Endodontic therapy or extraction is indicated (Emily & Penman, 1994, Harvey et al., 1983).

Avulsion occurs when there is detachment of a tooth from its alveolus with disruption of the periodontal ligament and pulp tissue attached (Harvey et al., 1983). If diagnosed early, replacement and splinting the affected tooth in place is indicated for

aesthetic purposes, especially if the root was still growing. For mature teeth, endodontic therapy is done before the tooth is replaced into the alveolus.

Trauma involving the pulp is followed by osteoclastic resorption of tooth structures with loss of the tooth over time. Internal resorption affects the dentine and this can be corrected by timely endodontic therapy. External resorption affects the alveolar bone and endodontic therapy has limited success in controlling this type of resorption with eventual loss of a tooth (Bojrab & Tholen, 1990, Emily & Penman, 1994, Harvey et al., 1983, Ettinger & Feldman 1995).

Attrition is wear attributable to occlusion between opposing teeth in dental arcades. This is considered physiological up to a certain point, otherwise excessive wear is associated with coarse diets or behavior attributes such as carrying hard objects in the mouth. No treatment is required if the wear extends only in to the dentine. Slow wear into the pulp is controlled by production of reparative dentine that appears brown and cannot be picked with a dental probe. Exposure of the vital pulp leads to necrosis and sometimes abscessation, requiring endodontic therapy or extraction. Chewing on metallic objects such as kennel grills or feeding bowls leads to a metallic coloration of teeth (Harvey et al., 1983).

Malar abscess usually appears as a soft fluctuant swelling on the side of the face just below the medial canthus of the eye. Also termed carnassial abscess or facial sinus, it may appear in the same location as a draining sinus tract, with communication of the tract with the oral cavity. The discharge is often clear with out other presenting clinical signs. The swelling is due to the necrosis of alveolar bone over the roots of

the upper carnassial tooth. Trauma, concussion from biting on hard objects and periodontal disease are common inciting factors. Radiography reveals a radioluscent area around the apex of the carnassial roots indicative of a periodontal abscess or apical cyst. If untreated, the complications may include maxillary osteomyelitis, sinusitis and parotid salivary duct injury. Extraction of the carnassial or endodontic therapy is indicated (Bojrab & Tholen, 1990, Emily & Penman, 1994, Harvey et al., 1983, Ettinger & Feldman, 1995).

2.1.3.8 ENDODONTIC DISEASE

This is infection involving the pulp cavity following exposure from a crown fracture, caries, or from an extension of periodontal disease. Pulp necrosis follows pulp exposure and inflammation with bacterial invasion. The bacteria invade the apex of the roots through the apical foramen. Leading to inflammation, liquefaction, necrosis and pain due to an acute periapical abscess. With time pus accumulates and seeks drainage via the root canal or fistula through facial planes, with attainment of a chronic state. Treatment is by endodontic therapy or extraction (Bojrab & Tholen, 1990, Emily & Penman, 1994, Harvey et al., 1983). Endodontic disease can also lead to local cellulitis with fever, pain and edema. Systemic antibiotic treatment and surgical drainage are required. Diagnosis of endodontic disease can be difficult since dogs have a high threshold for pain and signs of pain subside after pulpal necrosis (Harvey et al., 1983).

2.1.3.9 PERIODONTAL DISEASE

This is defined as acute and chronic gingivitis, periodontitis and periodontal abscess (Harvey et al., 1995). The severity of periodontal diseases has a direct correlation with the amount of dental plaque and calculi and the age of the dog. Calculi is uncommon in dogs below the age of nine months and starts forming on buccal surfaces of maxillary molars and the lingual surfaces of the mandibular cheek teeth in the region of the parotid duct. Soft diets have a positive correlation with periodontal disease (Harvey et al., 1983, Ettinger & Feldman, 1995).

Periodontal disease does not progress beyond gingivitis in a majority of dogs but can extend into the deeper structures of the periodontium, resulting in the loss of alveolar bone. This bone loss is progressive and can involve several teeth or a single tooth. Tooth roots are exposed and loosening occurs with eventual loss of teeth. Gingival hyperplasia may accompany the bone loss.

Radiographic diagnosis is based on the evidence of loss of crestal bone (Tsugawa & Verstraete, 2000) that recedes with progression of periodontal disease. Histologically, the condition is characterized by a chronic inflammatory reaction, osteoclastic activity in the crestal bone, and gingival sulcular pockets containing bacterial plaque, pus or calculi.

Treatment and prevention of periodontal disease is aimed at removing dental plaque and calculi by dental prophylactic scaling. Gingivectomy is also indicated to remove gingival pockets to facilitate removal of plaque and calculi (Bojrab & Tholen, 1990, Emily & Penman, 1994, Harvey et al., 1983).

2.2 EQUINE DENTISTRY

2.2.1 OVERVIEW OF DENTISTRY IN THE DONKEY

The donkey, *Equus asinus*, is a member of the Equidae family, as is the horse, *Equus caballus*, and the zebra, *Equus zebra*. The three are genetically related, as is reflected by the ability to produce viable non-fertile offspring such as the mule, the hinny and the zebro-donkey. This similarity and scarcity of clinical information on donkeys has led to the perception that the donkey is a small horse. However, differences in the behavior, physiology and management, influence the presentation, incidence and treatment of diseases in donkeys (Thiemann & Bell, 2001).

The donkey population in the world is approximately 44 million (FAO, 1997) of which 96% are in rural communities of developing countries. In Kenya, the donkey population is estimated to be 300,000 (FAO, 1997). Donkeys are owned by smallholder farming households, pastoralists and micro-entrepreneurs in the transport business (Svendsen, 1986, Fernando & Starkey, 2004). A general increase in donkey populations in sub-Saharan Africa and suggest that donkeys will continue to be important in these countries that have large rural populations without access to affordable motor power (Starkey & Starkey, 2004). In Limuru, one of the study areas, donkey ownership is high among farming households. This trend was noted in other communities visited during the research period. Kaumbutho et al. (2004) noted the lack of support services that would include veterinary clinical aspects that are needed to tap the enormous potential from this species. Enhancement of clinical services and sound management practices for the donkey are likely to improve the socio-economic status of these communities.

In Kenya, majority of donkey owners are subsistence farmers who use the animals for draught power. The donkey offers a relatively affordable, flexible, and readily accessible mode of transport compared to motorized vehicles or bicycles. Smallholder farmers use donkeys to cultivate by pulling ploughs. They also assist in cases of labor shortage and loss of other draught animals such as oxen to drought. Use of the donkey in agriculture and transport increases the productive potential and expands marketing options. Many people have created self-employment by hiring out donkeys and donkey carts (Fernando & Starkey, 2004). The animals are used to ferry perishables e.g. vegetables, milk, water for domestic use and building materials.

The donkey is often neglected, ill treated and overused. Historically, the donkey originated from Africa (Blench, 2004) and Asia, where it was tamed for use as a draught animal. Later it was introduced to the Mediterranean region and Europe, where it was referred to as 'the poor man's horse' (Soulsby, 1986). Lack of understanding, or the lack of resources to facilitate appropriate attention to this species, has lead to its neglect in many aspects. Two welfare organizations have been working in Kenya to improve the lot of donkeys i.e. Kenya Society for Protection and Care of Animals (KSPCA), Donkey Sanctuary Worldwide (DSWW) also called Donkey Sanctuary Overseas (DSO), and Kenya Network for Dissemination of Agricultural Technologies (KENDAT). Their work involves alleviation of suffering by client education through extension, provision of clinical services and promotion of efficient use of draught power. The established network between rural communities and the KSPCA - Donkey Sanctuary Worldwide offered a logistical advantage for this study.

Investments in donkey health and welfare contributes to alleviating poverty and achieving food security, as the donkey is used to ferry farm inputs and produce or draw ploughs to till the land (Soulsby, 1986). Practitioners must also be well informed and sensitive. This will increase the clinical interest in this equid, which has in the past been limited, as evidenced by the lack of objective data in literature (Thiemann & Bell, 2001).

The state of the teeth in the equine affects the digestibility of crude fiber and protein. Improved digestibility is associated with routine and regular floating to achieve proper molar teeth occlusion (Ralston et al., 2001). This finding emphasizes the importance of regular dental care for donkeys. Teeth in the donkey take longer to develop than in the horse (Muylle et al., 1999). This physiological difference may mean that the wear rates and patterns may not be similar for the donkey and the horse. Aging by dentition is similar to the horse or pony with regard to eruption times. However later age related changes differ (Crane, 1997). Whitehead et al. (1991) have developed a technique for aging by tooth inspection, specific for donkeys.

The equidae utilize all their teeth when feeding. The lips are used to maneuver the blades of grass or hay into the mouth while the incisors cut off the grass. The tongue then presents this to the cheek teeth for thorough grinding before it is swallowed. This process actively engages all the teeth in the mouth. Conditions affecting teeth, or structures associated with the teeth will affect digestion leading to the loss of stamina and body condition, and the possibility of development of digestive disorders causing colic. The use of the harness in working donkeys as opposed to the bit in horses delays the manifestation of dental conditions since the harness does not interfere with

the oral cavity, as the bit would do. Nevertheless the lack of overt signs of dental conditions should not compromise the need for regular routine checkups.

Irregular wear of molars may distort the dental arcades producing caudal or rostral hooks among other abnormalities in wear such as wave mouth, sharp enamel edges or stepped mouth. This necessitates routine annual or twice yearly rasping especially for those donkeys over 15 years of age, or those with a history of dental disease. Loose teeth become common over 20 years of age and can easily be extracted and opposing teeth monitored for overgrowth. Surprisingly, most donkeys will keep in good body condition even with excessive wear or loss of teeth (Crane, 1997).

Clinical signs associated with dental conditions in donkeys may include; head shaking, head tossing, retention of feed boli in the oral cavity, pain on handling the face, foul smell from the oral or nasal cavities, reluctance to feed, holding of the head to one side, quidding of food from the mouth and a high proportion of undigested fiber in the feces. Others are colic, dull coat, loss of body condition, swellings on the face, epistaxis and hemorrhagic or purulent nasal discharge and draining abscesses from the jaw (Svendsen & Soulsby, 1986, Patrick et al., 1991).

The objective of a physical dental examination that is prompted by the occurrence of suggestive clinical signs is to quantify oral and dental disorders, carry out appropriate treatment, and implement changes in the management programs to prevent the recurrence of specific conditions. It is also important to determine the prognosis and the affordability of the treatment options to the owner (Baker, 1998).

The herbivorous diet of the donkey contains fiber and mineral elements such as silicates in form of sand and soil that continually wear teeth down during mastication. To compensate for this wear, teeth grow continuously in order to maintain occlusion and effective mastication. Interference with the equilibrium in this process leads to most of the abnormalities (Emily & Penman, 1994). Hooks and steps are common, especially when opposing teeth are lost, broken or misplaced. Conditions associated with periodontal disease such as periapical osteitis are uncommon compared to conditions due to abnormal wear.

2.2.2 DENTAL ANATOMY IN THE EQUIDAE

Equids have teeth modified to suit their herbivorous diets (Vollmerhaus et al., 2002). The modifications are formation of reserve crowns, continuous eruption and development of enamel cementum. All the cheek teeth have similar morphology, with premolars resembling molars for efficient grinding of feed. The enlargement of the premolars and their assimilation to the molars, with which they present a continuous grinding surface, increases the masticatory area. Attrition wears the cheek teeth by about 2-3mm per year. To compensate for this, a greater part of the crown is embedded within the jaw and is gradually extruded (Dyce et al., 1987). Like in all mammals, the tooth is composed of pulp, dentine, enamel and cementum. The enamel is greatly folded to increase the surface area for efficient grinding. The pulp is a soft gelatinous mass occupying the pulp cavity in the central part of the tooth. In the upper teeth, the pulp cavity has five main divisions while in the lower teeth it has two main divisions. These divisions correspond to the folds in the enamel. The dentine is hard, yellow or white and surrounds the pulp cavity. The dentine encroaches on the pulp cavity with age contributing to the characteristic wear patterns. The enamel covers the dentine and is harder, appearing whiter. Cementum is dark and is the most peripheral

of the layers. It functions to level out the irregularities in the enamel folds and also contributes to the various wear patterns with age (Dyce et al., 1987).

The incisors form a continuous arch in each jaw and their roots converge. Each is curved lengthwise forming a labial convexity. When in occlusion, the incisors in young animals form a continuous arch when viewed in profile. With age, wearing causes the teeth to meet at a more pronounced angle. Continuous wear would eventually expose the pulp, but this is prevented by timely formation of secondary dentine that is darker than primary dentine, thus forming a dental star. Canines are rudimentary and often fail to erupt in mares. In males they are small, laterally compressed cones in the diastema. The first premolar (wolf tooth) is vestigial and may only be present in the upper jaw and is of no functional significance. The premolars form a continuous row with the molars and it may be difficult to distinguish individual teeth. The upper cheek teeth are wider with more complex enamel folding with infundibula. The lower cheek teeth have no infundibula. The occlusal plane slopes ventrobuccally. The upper cheek teeth are anchored by three or four roots. These roots and the embedded crowns are closely related to the maxillary sinuses.
The deciduous teeth are smaller, with a constricted neck and are whiter than permanent teeth. Longitudinal striation may also be present on deciduous teeth. Permanent teeth, on the other hand, have a slightly yellow and porous appearance due to cement encrustations (Dyce et al., 1987, Patrick et al., 1991, Lowder & Mueller, 1998). The schematic representation of dental anatomy is given in Figure 3 & 4.

Figure 3; Profile view of an equine skull indicating cheek teeth, canines and incisors. (Textbook of Veterinary Anatomy-Dyce et al., 1987)

Figure 4; dental arcades from the maxilla (left) and mandible (right) in the equine. Incisors (I), canines (C), premolars (P) and molars (M). wolf tooth (1) and diastema (2). (Textbook of Veterinary Anatomy-Dyce et al., 1987)

2.2.3 DENTAL CONDITIONS AND INTERVENTIONS IN THE DONKEY

2.2.3.1 MAXILLARY AND MANDIBULAR DEFORMITIES

The mandible may be longer than the maxilla or vice versa. This is also referred to as mandibular or maxillary prognathism. It may also be referred to in relation to the shortened jaw thus mandibular or maxillary brachygnathia. This results in varying degrees of lack of occlusion of the incisors thus abnormal wear and overgrowth. Hooks may form on the first maxillary cheek teeth and sixth mandibular cheek teeth (Patrick et al., 1991). Treatment is palliative involving regular rasping.

2.2.3.2 SUPERNUMERARY TEETH

Also referred to as polyodontia, this is the presence of additional teeth to the total number of normal teeth. It is common with the incisors due to the division of the permanent tooth germs thus duplication of permanent teeth (Patrick et al., 1991). If the extra teeth are in occlusion and have normal wear they have no effect on the dental health. If they do not wear normally, frequent rasping should be done. Excessively long or misplaced teeth should be extracted.

2.2.3.3 DENTIGEROUS CYSTS

Dentigerous cysts arise from the enamel organ during embryological development. They are lined by stratified squamous epithelium and contain one or more teeth. They may drain into the ear canal. These cysts are also referred to as temporal teratomas or heterotopic polyodontia (Patrick et al., 1991). Treatment is by surgical dissection and obliteration of the dead space.

2.2.3.4 CYSTIC SINUSES

Cystic sinuses are also called mucoid degeneration of the nasal turbinates, multiple mandibular cysts or osteodystrophia fibrosa cystica (Patrick et al., 1991). They are commonly seen in young animals as facial or mandibular distortion, or nasal obstruction. Although surgical drainage may relieve the symptoms, it is not curative.

2.2.3.5 ABNORMAL TOOTH ERUPTION

The third cheek tooth (fourth premolar) is the last permanent tooth to erupt. It is the most common site of impaction, rotation or medial displacement. Maxillary, mandibular or incisive bone fractures that destroy permanent tooth germs may also result in permanent tooth deficiency, dental impaction or displacement (Patrick et al., 1991). Tooth displacement may cause injury to the hard palate. Overcrowding of teeth in the dental arcades may be due to shortening of the maxilla or mandible. Overcrowding delays eruption and leads to tooth impaction with painful swelling on the alveolar bone. Removal of deciduous caps prevents occurrence of this condition.

2.2.3.6 WOLF TEETH

These are vestiges of the first premolar tooth and are frequently in contact with the second maxillary cheek tooth. They are of no significance in the donkey since bits are not used in this species, unlike in the horse.

2.2.3.7 ABNORMAL DENTAL WEAR

This includes the conditions described below.

2.2.3.7.1 SHARP ENAMEL POINTS

The incomplete wear of the buccal surfaces of the maxillary cheek teeth and the incomplete wear of the lingual surfaces of the mandibular cheek teeth forms sharp enamel points along the edges of the dental arcades. This is due to the mandible being narrower than the maxilla. Caudal retraction of the mandible also causes hooks to develop on the first maxillary and the last mandibular cheek teeth. The sharp points cause injury to the tongue and the buccal mucosa with decreased food intake due to reluctance to chew. Correction is by regular floating.

2.2.3.7.2 WAVE MOUTH

Exaggeration of the transverse wear pattern leading to the wavy appearance of the dental arcades causes this abnormal pattern (Patrick et al., 1991). Correction is by rasping and in extreme cases compound molar cutters can be used to reduce the unevenness.

2.2.3.7.3 STEP MOUTH

Marked variation in the height of individual cheek teeth, usually due to unequal wear of opposing teeth or secondary to extraction, characterizes this condition. Treatment is by regular rasping.

2.2.3.7.4 SMOOTH MOUTH

Excessive wear or loss of teeth in old age causes this condition. Excessive rasping in young animals may also cause the condition. Provision of finely chopped feed maintains the animal's condition since there is no treatment.

2.2.3.7.5 RETAINED DECIDUOUS TEETH

These are deciduous cheek teeth that remain attached to the permanent cheek teeth after the latter have erupted. They are also called dental caps (Patrick et al., 1991). The caps may rotate and cause injury to the buccal mucosa. Removal of the caps should only be done after the permanent tooth has erupted above the gingival margin. Retained temporary incisors tend to be more firmly attached and are more likely to cause injury to the labial mucosa and displacement of the permanent teeth. Prompt extraction should be done with dental forceps.

2.2.3.7.6 PERIODONTAL DISEASE

This condition is inflammatory and dystrophic in nature causing malnutrition, halitosis, maxillary and mandibular osteitis, paranasal sinusitis, nasal discharge or colic. Initial lesions start as gingivitis with hyperemia and edema. The gingival sulcus is eroded and deepened, forming a pocket where food accumulates, further irritating and destroying the periodontium. Alveolar sepsis develops, with loosening and loss of the tooth. The condition is caused by changes in the normal masticatory forces on teeth, associated with abnormal wear. Prevention is by regular dental prophylactic floating and provision of appropriate diet such as natural grazing.

2.3 CURRENT STATUS OF VETERINARY DENTISTRY IN KENYA

Veterinary dentistry remains an obscure aspect of veterinary practice in Kenya due to lack of specialty status. Most practices are defined by the predominance of either large animal or small animal cases that are attended. Only in the recent past is this trend changing due to the increasing awareness and globalization influences. There is need to create interest in specialty fields of veterinary medicine such as dentistry in the country and the region. A research project was designed to document dental conditions encountered in clinical practice outlining available interventional modalities and their outcomes. This will form a basis for development of veterinary dentistry as a specialty discipline.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 STUDY ANIMALS

Two hundred and thirty five dogs from the Small Animal Clinic, Department of Clinical Studies, Faculty of Veterinary Medicine, College of Agriculture and Veterinary Sciences, University of Nairobi were used. One thousand, two hundred and eleven donkeys from the KSPCA-DSWW clinics at Langata, Bomet, Nyahururu, Mweiga, Naivasha, Naromoru, Maai-mahiu and Limuru were assessed.

3.2 DENTAL EXAMINATION IN DOGS

3.2.1 PRELIMINARY DENTAL EXAMINATION

The examination procedure was done following the format in the dental records (Appendix 1). Preliminary dental examination of dogs included review of previous dental history, existing home dental care and diet. Periodontal examination involved assessment the color of mucus membranes, determination of oral odour, symmetry of the dental arcades, anchorage of teeth in the dental alveoli and periodontal probing using a graduated periodontal probe. Radiology was done for selected cases.

Percussion to assess integrity of sub-gingival structures and pain achieved endodontic evaluation. Dental radiology was also done for selected cases with endodontic changes. Examination was extended to the oral structures including soft and hard palate, buccal and lingual gingivae, buccal mucosa, the tongue, frenulum, salivary papillae, tonsils and the lips. This was done to document miscellaneous conditions and signs associated with dental conditions in dogs.

Xylazine Hydrochloride (XYLAZINE 20 Inj., KEPRO, HOLLAND) was used at 1mg/kg body weight for sedation in uncooperative patients and as a premedicant before induction of general anaesthesia.

Dental procedures were done under general anaesthesia which was induced and maintained with Thiopentone Sodium (THIOPENTAL Inj., BP 500, ROTEXMEDICA, TRITTAU, GERMANY) at 10mg per kilogram body weight intravenously. In prolonged procedures, maintenance of anaesthesia was done using Halothane-Oxygen mixture delivered via a cuffed endotracheal tube with a closed circuit anaesthetic machine. Use of cuffed endotracheal tubes prevented aspiration of cleansing solutions during dental procedures. Findings from dental examination were recorded in Modified Triadan dental charts (Appendix 1). A digital camera was used to photograph the dental findings encountered in the study and copies stored electronically.

3.2.2 DENTAL RADIOGRAPHY

Radiography was done to identify changes associated with dental conditions including periodontal pockets, bone loss, and apical abscesses. Dental radiology was incorporated in this evaluation to assess the height, of the alveolar crestal bone, continuity of the periodontal ligament space, radiographic presence of the lamina dura, periapical radiolucency, bony trabecular changes, retained roots, and other non-odontogenic changes.

Radiographic diagnosis facilitated the choice of the appropriate intervention technique. Dental radiology was done in twelve dogs all under general anaesthesia as described for effective restraint. Personnel in radiology procedures used lead gloves and aprons for radiation safety.

The radiographic techniques used were adapted from Emily and Penman (1994) and included; bisecting angle (intra-oral and extra-oral), intra-oral parallel, and extra-oral parallel. Intra oral bisecting angle technique was used for maxillary and mandibular incisors and canines. Intra-oral parallel technique was used for mandibular premolars and molars. The extra-oral parallel or intra-oral bisecting angle techniques were found useful for maxillary premolars and molars. The bisecting angle technique was used to accommodate the entire root of the canines and to cope with the flatness of the hard palate in exposing the maxillary teeth and mandibular canines and incisor.

Plain radiography was done using standard medical x-ray film (XBM, X-RAY RETINA 30x40cm 100NIF, GMBH, Berlin, Germany) (Figure 5). Dental radiography was done using dental film (Kodak Dental Intra-oral D-Speed Film, 31x41mm, E.K.C Rochester, NY 14650, USA) (Figure 6). A mobile standard X-ray machine was used for the exposure (Practix 33 Plus, Mobile Radiography system, ©2000 Philips Medical Systems, Roentgenstrasse 24, D-22335 Hamburg, Germany) (Figure 7).

Figure 5; Conventional 300x400mm X-Ray Film Cassette.

Figure 6; Intra-oral 31x41mm Dental Film.

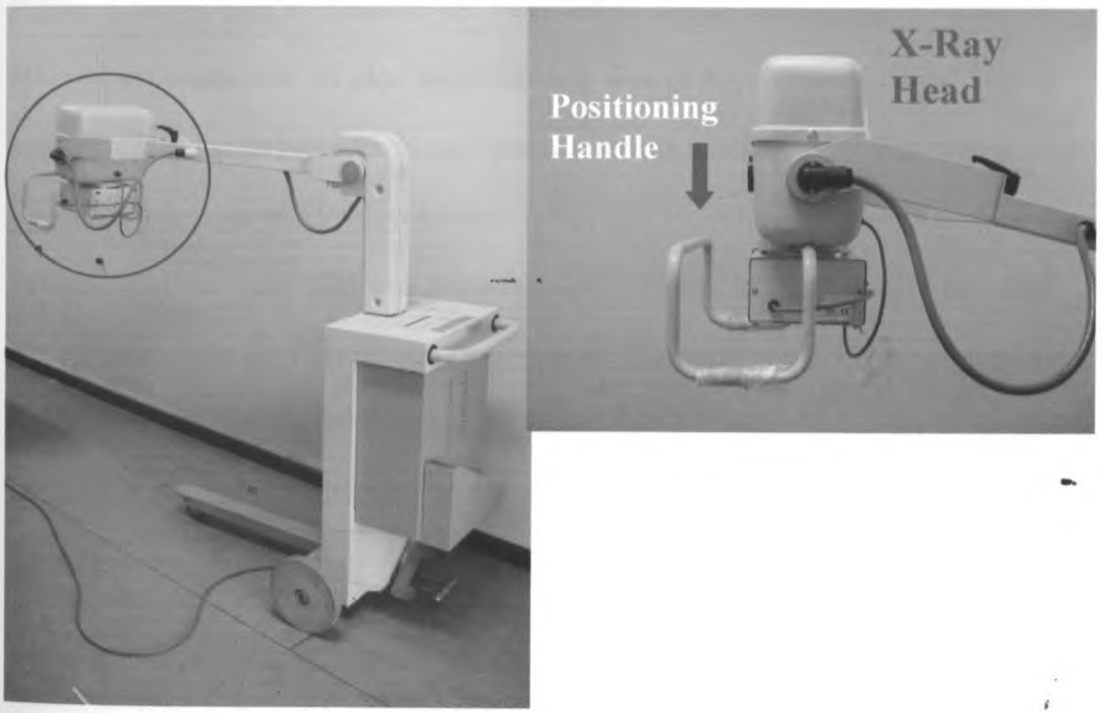


Figure 7; Mobile X-Ray Machine. Detail of X-Ray head (circled) is given on the right.

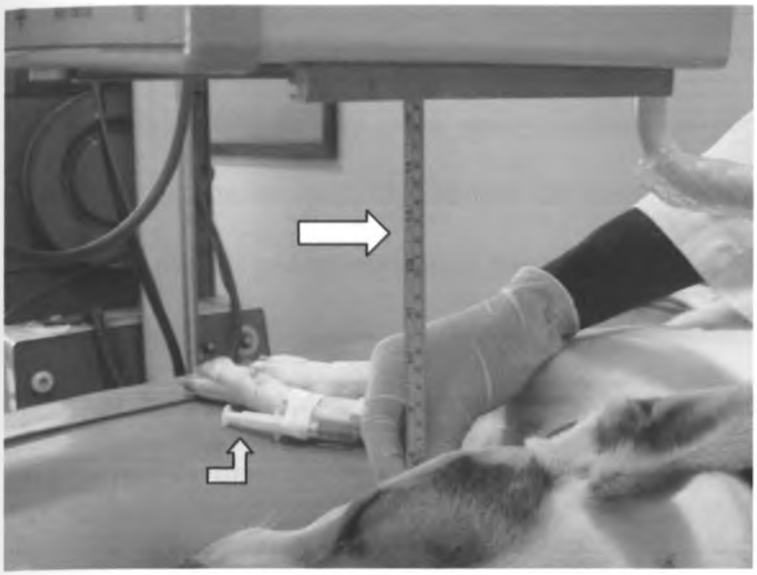


Figure 8; Determination of Film Focal Length. White arrow shows a retractable rule. General anaesthesia was maintained intravenously (yellow arrow) avoiding the use of an endotracheal tube that would interfere with radiography.

The focal length used in the dental radiography in this study was less than 2-5cm. Figure 8 shows how to measure the focal length during radiography. Collimation allowed exposure over an area approximating that of the intra-oral dental film or encompassing the targeted teeth only when standard medical x-ray film was used. Exposure was done at 55 kilovoltpower (kVp) and 10 millamperes seconds (mAs). Ordinary medical x-ray film was processed for 5 minutes in the developer and fixed for 2-3 minutes in the fixer. It was then rinsed in tap water and dried for evaluation. Non-screen intra-oral dental film was processed for 15 minutes in the developer and fixed for 5 minutes. A dental film holder was used to handle the intra-oral dental film during processing and drying.

3.2.2.1 INTRA-ORAL TECHNIQUES

This was done using specialised intra-oral dental film that could easily be positioned in the mouth. Standard medical x-ray film was also used for the maxillary and mandibular canines and incisors.

3.2.2.1.1 INTRA-ORAL BISECTING ANGLE TECHNIQUE

The bisecting angle technique was used to radiograph maxillary incisors, canines, premolars and molars with the patient on sternal recumbency. Radiography of mandibular canines and incisors using this technique was performed with the patient on dorsal recumbency.

An imaginary line is drawn between the long axis of the tooth (a line drawn to touch the apex and the tip of the crown) and the x-ray film so as to bisect the angle between these two and then the primary x-ray beam is directed at right angles to this bisecting line (Figure 9). This gave an accurate representation of the tooth without shortening or elongation of the radiographic image. The x-ray film was placed in the mouth in contact with the occlusal surfaces of the tooth, and angled towards the long axis of the tooth of interest. This was done without bending the film, to avoid image distortion. For canines and incisors, the beam was directed obliquely rostro-caudally, while for the cheek teeth the beam was directed latero-medially.

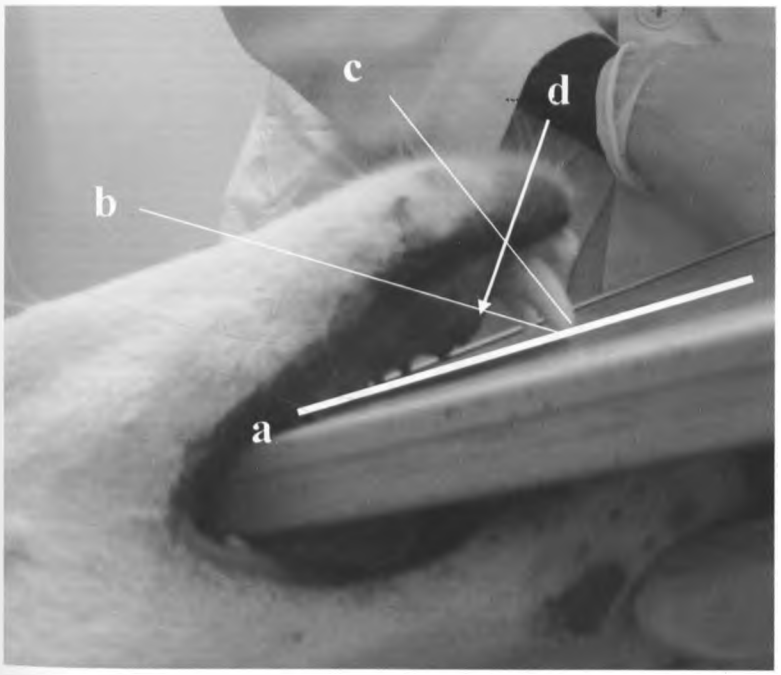


Figure 9; Bisecting Angle Technique used on a mandibular canine – x-ray beam (d) at 90o to bisection (b) between long axis of tooth (c) and the x-ray film (a).

3.2.2.1.2 INTRA-ORAL PARALLEL TECHNIQUE

The patients were placed in lateral recumbency with the area of interest uppermost. The intra-oral film was then positioned on the lingual aspect of the lower premolars or molars to be radiographed, with the film pressed against the tooth and the gum, ensuring it included the apex. This ensured that the film was parallel to the long axis of the tooth. The x-ray beam was directed at right angles to the long axis of the tooth and film (Figure 10).

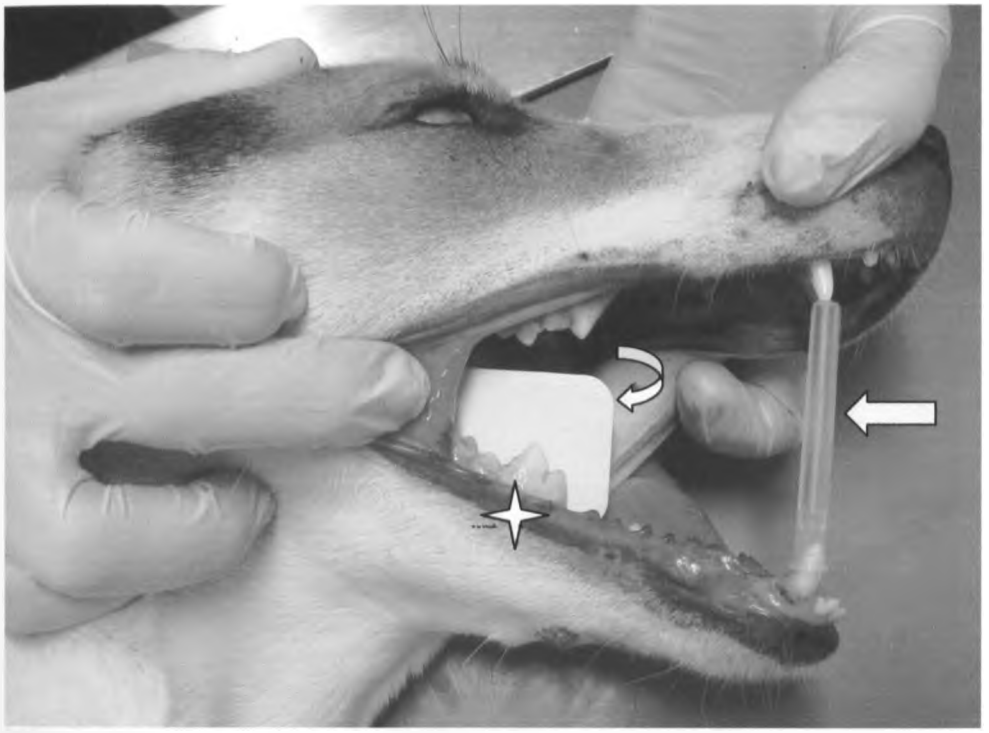


Figure 10; Parallel Technique radiography of a mandibular carnassial – dental film (curved arrow) placed on lingual aspect of tooth parallel to its long axis. Straight arrow shows a hypodermic needle cover used to keep the mouth open. The x-ray beam is directed at right angles to long axis of the tooth, at a point marked by the star.

3.2.2.2 EXTRA-ORAL RADIOGRAPHY

Conventional dental film and standard medical x-ray film were used for extra-oral radiography of teeth. The various techniques used under this category are detailed below.

3.2.2.2.1 OBLIQUE LATERAL TECHNIQUE

This was done for mandibular and maxillary cheek teeth. Superimposition and shortening of the images can occur in radiographs taken in this technique. The patient is placed on lateral recumbency with the x-ray film under its head. The mouth is held wide open and the head tilted at an angle of approximately 45^{o} to expose the lingual aspect of the targeted teeth to the x-ray beam while minimising superimposition from the opposite arcade (Figure 11).

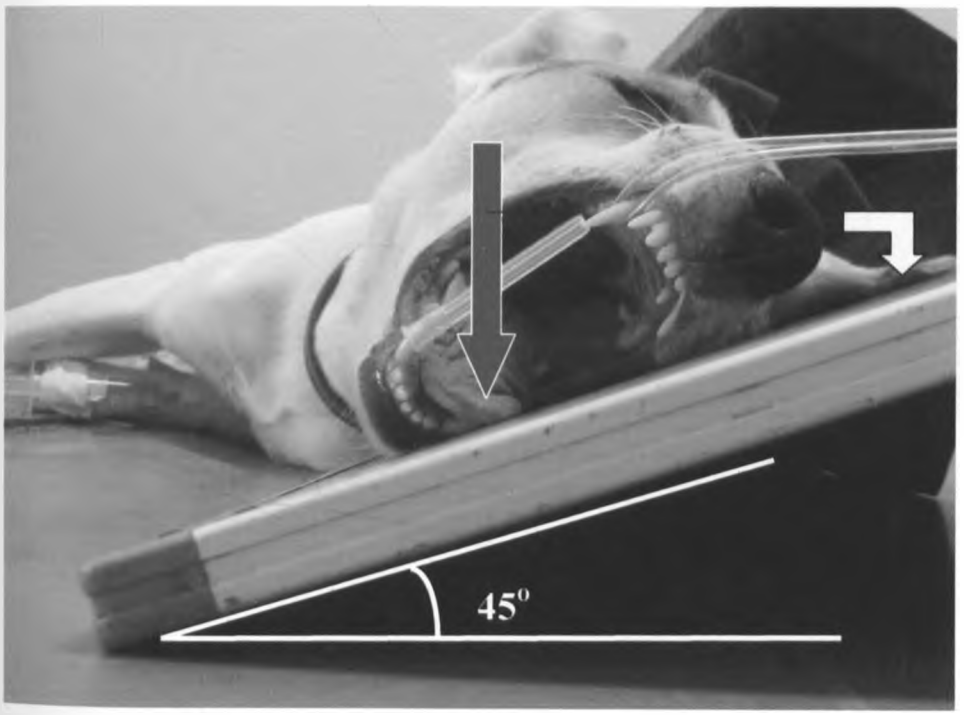


Figure 11; Oblique Lateral radiography of a mandibular canine to minimize superimposition. Blue arrow depicts path of the x-ray beam; white arrow shows the position of the x-ray film.

3.2.2.2.2 BISECTING ANGLE TECHNIQUE

The extra-oral bisecting angle technique requires the use of positioning aids such as foam and wooden blocks with the patient in lateral recumbency, the x-ray beam is directed at right angles to a line bisecting the angle between the long axis of targeted teeth and the x-ray film (Figure 12). As with other extra-oral techniques, superimposition and shortening of images can occur in radiographs taken with this technique.

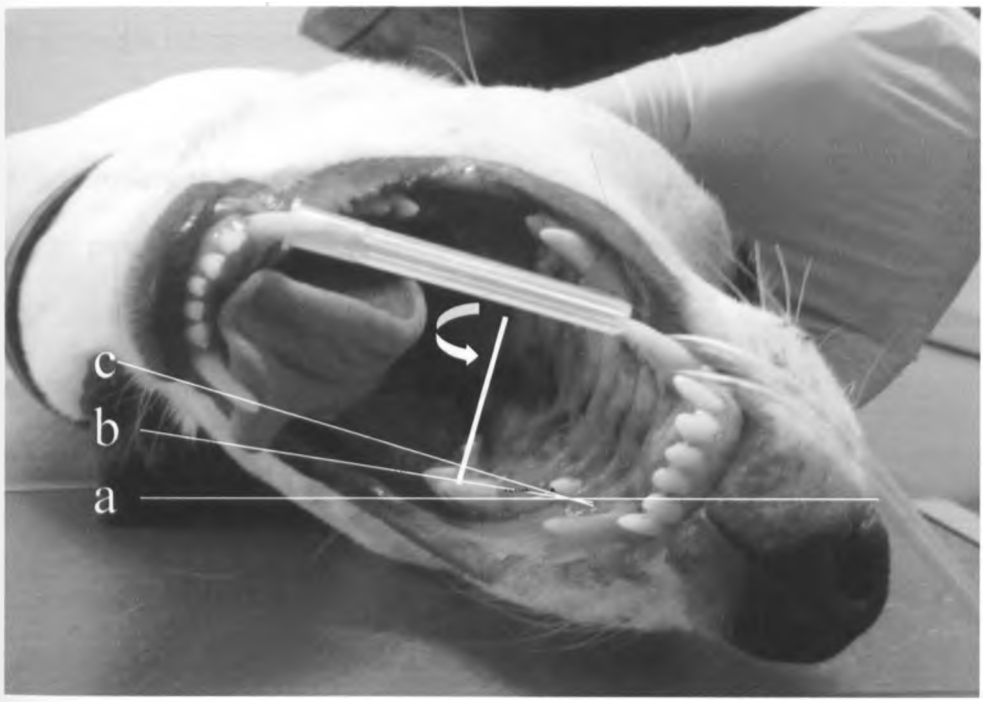


Figure 12; Extra-oral bisecting angle radiography of the maxillary carnassial. The bisection (b) between the long axis of the plate (a) and the long axis of the tooth (c). X-ray beam at right angle to the bisection, depicted by the curved arrow.

3.3 INTERVENTIONS FOR DENTAL CONDITIONS AFFECTING THE DOG

Dental interventional procedures were prescribed depending on the observed dental condition, available dental instruments, prognosis of the case, and willingness of clients to follow through with the proposed procedure. Manual instruments were used in this study.

All dental procedures were done under general anaesthesia as described earlier. In one geriatric patient, dental prophylactic procedures were done under sedation using Xylazine Hydrochloride (XYLAZINE 20 Inj., KEPRO, HOLLAND) at 1mg per Kg body weight intramuscularly.

Dilute hydrogen peroxide was used for sanitization to flush the oral cavity during dental procedures. Hydrogen peroxide is an oxidising agent and by its frothing action, dislodges organic debris from teeth surfaces, between adjacent teeth and from surfaces of oral mucus membranes. Plain water was used to rinse the oral cavity, and then dilute povidone iodine (Betadine) solution after completion of the procedures. Povidone iodine is a potent antimicrobial agent active against a wide variety of bacteria, protozoa and fungi. It also cauterises and controls minor bleeding from gums, such as would occur during dental scaling.

3.3.1 ROUTINE DENTAL PROPHYLAXIS

A diamond shaped manual scaler was used to remove supra-gingival dental calculi , (Figure 13). Sub-gingival dental calculi were removed by use of a fine dental curette and shepherds crook pointed tip manual scaler (Figure 14). Root planing was done using a fine dental curette to remove all necrotic and diseased cementum to make the

surfaces of exposed roots smooth and free from organic debris. Crown polishing was done after removal of supra-gingival calculi to make the enamel smooth, which is aesthetic and also prevents accumulation of debris and plaque. Polishing was done manually using a fine curette followed by brushing using a pet toothbrush with stiff nylon bristles. Manual dental instruments used in prophylaxis are shown in Figure 16.

Figure 13; Supra-gingival scaling using a straight diamond shaped manual scaler.

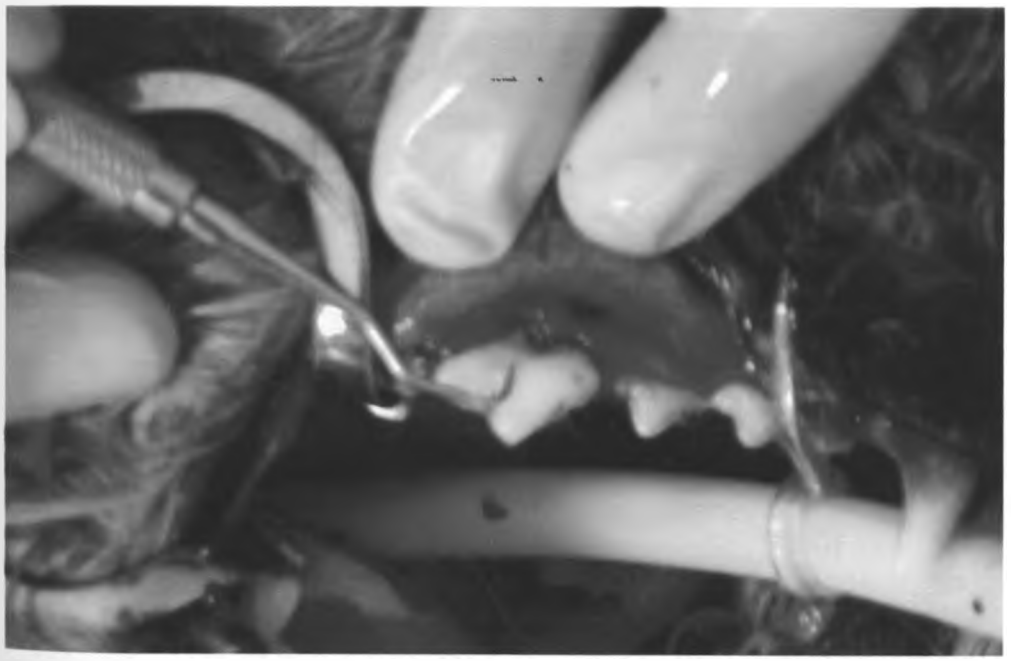


Figure 14; Shepherd's Crook pointed tip manual scaler used for subgingival scaling.

3.3.2 EXTRACTION

Irredeemable teeth were extracted using previously described extraction techniques (Bojrab & Tholen 1990, Emily & Penman 1994). For single root teeth the periodontal ligament was loosened by the use of a dental luxator (Figure 15 & 17). The tooth was then released by gentle elevation using a dental elevator. Axial rotation was then done by twisting the loosened tooth using extractor forceps as the tooth was extracted from its alveolus. Two root teeth were extracted by rocking motion using extractor forceps (Figure 17). This was after luxation of the periodontal ligament by use of a dental luxator and elevator. Three root teeth were extracted after initial sectioning by use of a wire saw to convert the anterior portion into two roots and the posterior portion to single root. The single root segment was extracted by axial rotation while the two-root section was extracted by rocking using extractor forceps. After the extractions, the vacant alveoli were packed with sterile cotton gauze swabs. Digital pressure applied for up to a minute achieved hemostasis. Occasionally the swab would be soaked in diluted Lugol's iodine when bleeding was persistent.

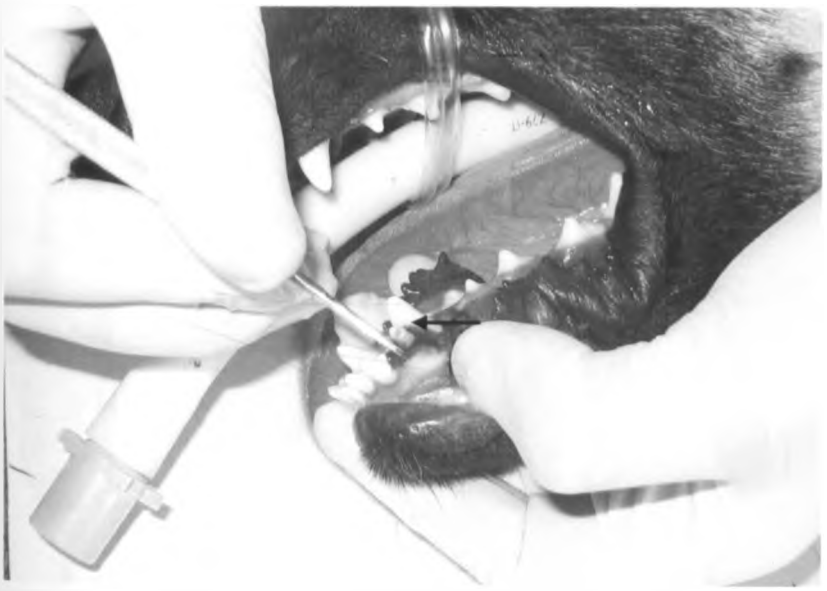
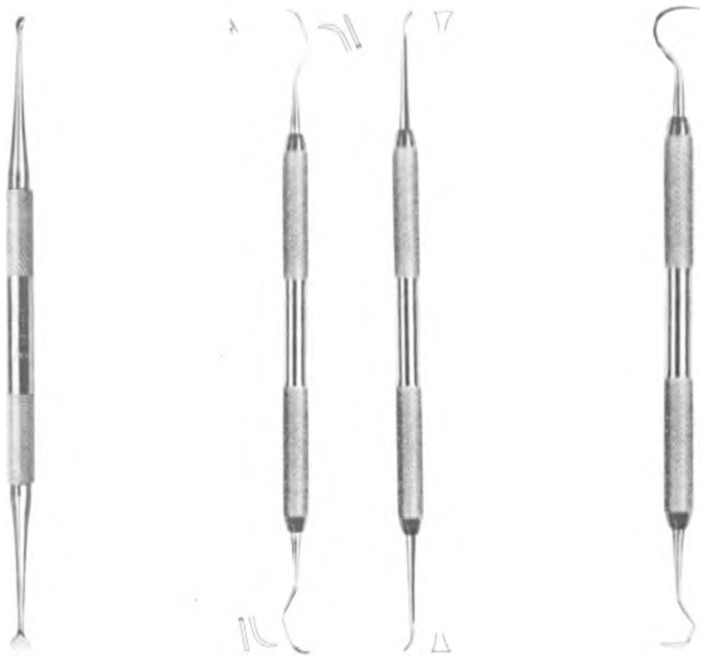
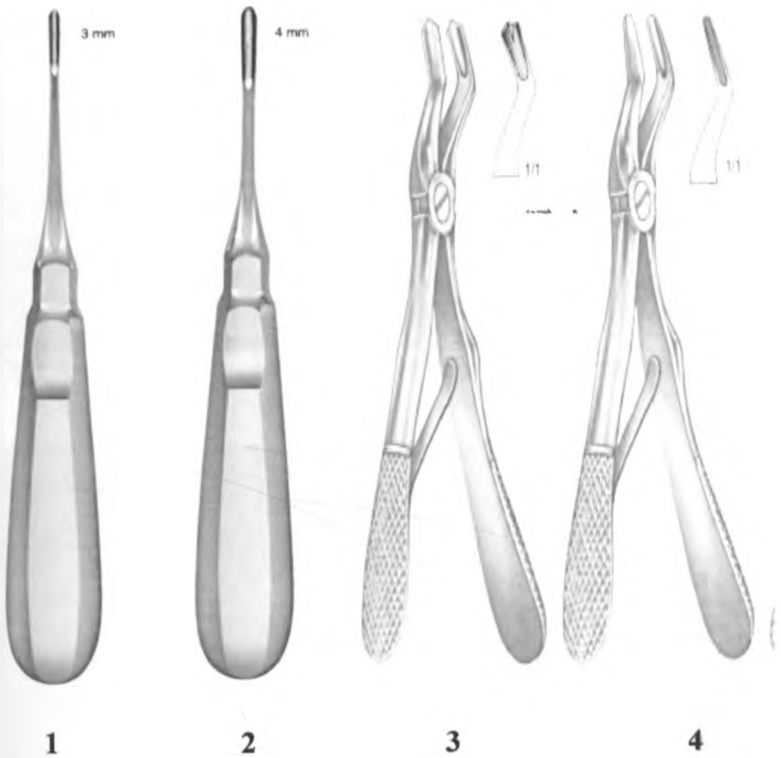


Figure 15; Releasing the root using a dental elevator in extraction of a persistent deciduous canine (arrow).



1 2 3 4

Figure 16; Manual dental instruments. Dental curettes (1&2), dental hoe scaler (3) and dental shepherds crook scaler (4).



1 2 3 4

Figure 17; Dental instruments used for extraction. Dental luxators (1&2) and dental extractors (3&4) (Manual instruments by Bontempi s.n.c.-Italy)

3.3.3 SOFT TISSUE SURGICAL PROCEDURES

Surgical procedures on soft tissues included minor periodontal surgery such as gingivectomy to excise hyperplastic gingivae and gingivoplasty to obliterate gingival pockets. Other procedures involved restorative cheiloplasty to repair wounds and defects involving the lips, and antidrool cheiloplasty for reduction of uncontrolled drooling. All procedures were done under general anaesthesia with an inflated endotracheal tube in place.

3.3.3.1 GINGIVECTOMY

This was done using a Bard Parker No. 15-scalpel blade to excise hyperplastic gingival flaps (Figure 18). The aim of dissection was to achieve even gingival margins for a normal anatomical contour (Figure 19).

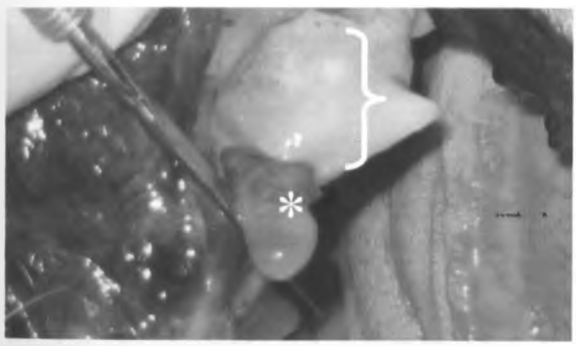


Figure 18; A hyperplastic gingival flap before excision (*) and Calculi (}).

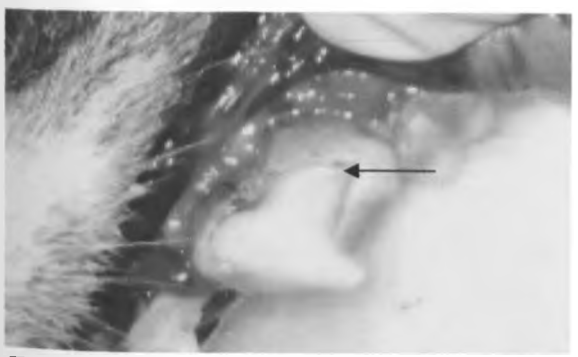


Figure 19; Hyperplastic gingival flap excised and part of calculi scaled (arrow).

3.3.3.2 GINGIVOPLASTY

Gingivoplasty was done by excising excessive tissue from the gum margins such as hyperplastic flaps using Bard Parker No. 15-scalpel blade. Large defects were sutured using fine monofilament polyamide non-absorbable suture No. 2-0 with a round-bodied eyeless needle in a simple interrupted pattern. The aim of gingivoplasty was to reduce or completely remove gingival pockets, important in preventing debris from lodging in the gingival sulcus.

3.3.3.3 RESTORATIVE CHEILOPLASTY

Surgical correction of a lip defect following a laceration wound was done in one patient. Healing following initial repair had led to a defect distorting the lip margin. Surgery entailed freshening the wound margins with a scalpel blade No. 22. The skin of the lip was undermined by sharp dissection to free it at the wound margins for suturing. The obicularis oris muscle was apposed with chromic catgut No. 2-0 in a simple interrupted pattern. Skin was apposed using Nylon No. 2-0 starting from the mucocutaneous junction (Figure 20).

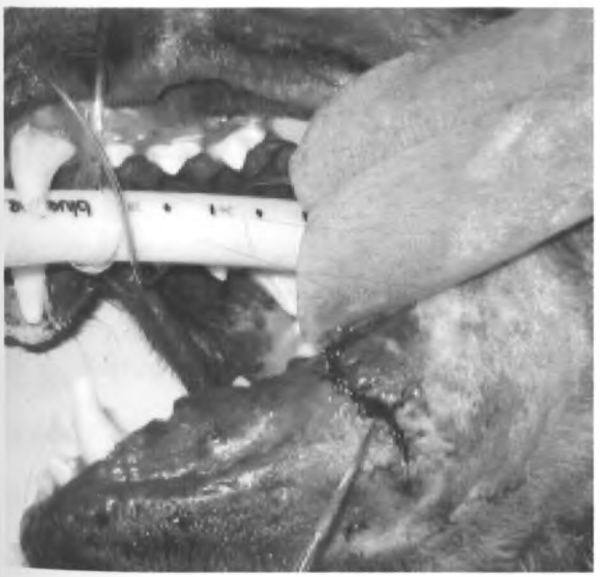


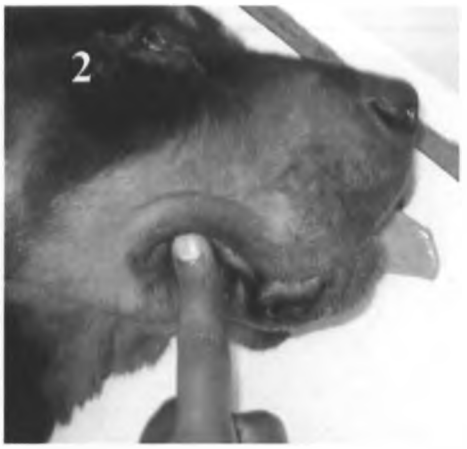
Figure 20; Repaired wound after restorative cheiloplasty.

3.3.3.4 ANTIDROOL CHEILOPLASTY

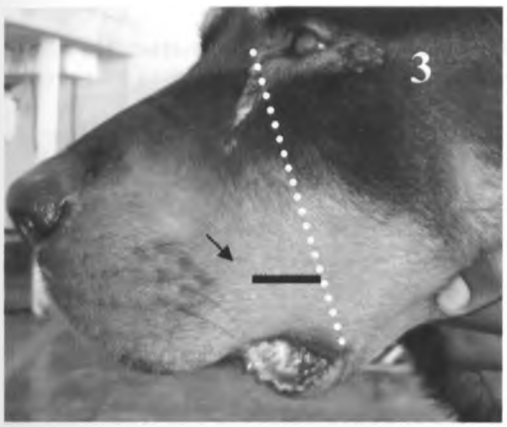
The aim of this procedure was to reduce unsightly drooling and improve aesthetics in a patient that also had cheilitis. The procedure corrects the eversion of the mucocutaneous border of the lower lip. This is done to reduce the loss of food and saliva from the lateral vestibules of the oral cavity. The procedure was adopted from Bojrab et al. (1998) and is illustrated in Figures 21 and 22. For gingivoplasty and restorative cheiloplasty, the sutures were removed after ten days. Sutures were, however, left in place for three weeks following antidrool cheiloplasty, to achieve satisfactory healing with functional adhesion between the lower and upper lips.

Post operative care for patients undergoing soft tissue surgery included; Amoxycillin trihydrate (BETAMOX LA, Norbrook Laboratories Ltd. Newry, Co. Down, Northern Ireland) administered intramuscularly at 15 mg/kg body weight and maintained at 30 mg/kg body weight orally (PENAMOX 250 mg Capsules, SmithKline Beecham Pharmaceuticals, Medreich Sterilab, Virgonagar, Bangalore, India) three times a day for five days. Amoxycillin has broad spectrum activity especially against gram-positive bacteria. Metronidazole (METRONIDAZOLE 200 mg BP, Medopharm, 1.Thiru-vi-ka Road, Chennai, India) given orally at 30 mg/kg bwt (Plumb, 1999) for seven days provided antimicrobial action against gram-negative organisms and flagellates. It was used for the patient that underwent antidrool cheiloplasty.

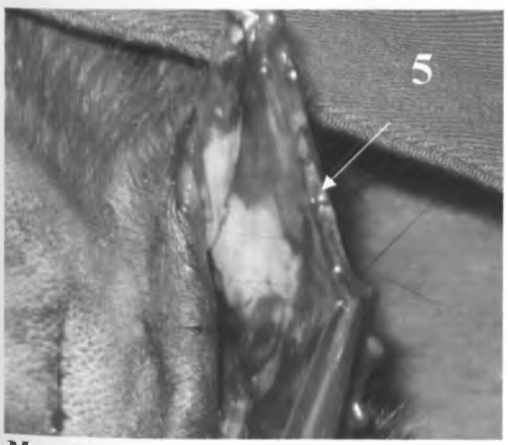
All patients were given phenylbutazone (PHENYLBUTAZONE 20% Inj., KEPRO B.V., Barneveld Holland) at 15 mg / kg body weight intramuscularly once every 48 hours for pain management. Patients were fed on a soft diet for at least 2 days following surgery. Oral flushing with plain water was done after meals to dislodge food material from the oral cavity to allow healing of surgical wounds.

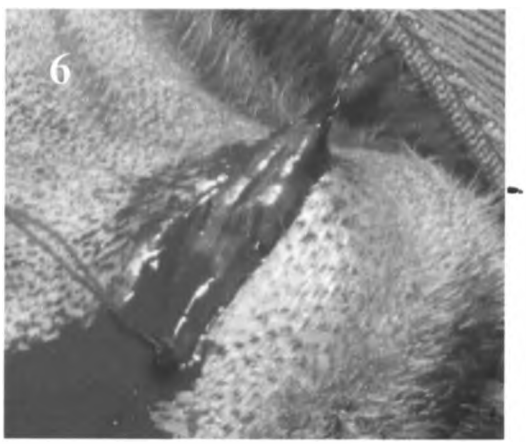


Slack in the lower lip with eversion of the margin. Digital elevation of lower lip to determine the dorsal extent of the horizontal cheek incision.



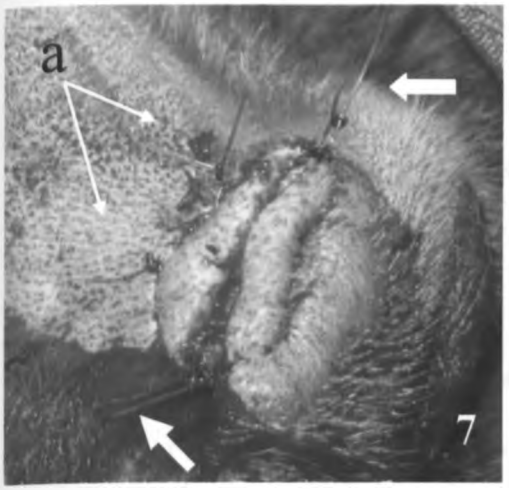
Cheek incision (arrow), whose caudal extent touches imaginary line (dotted).

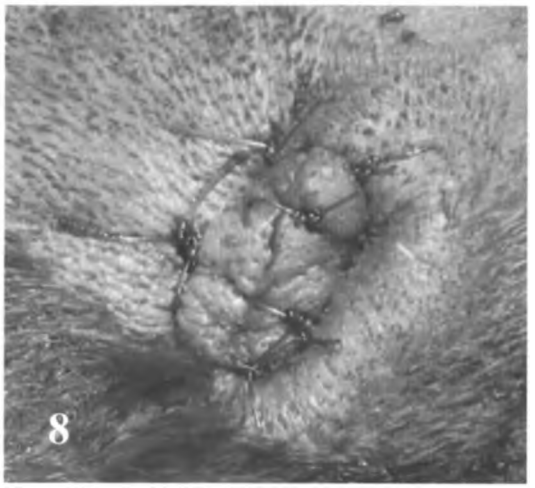




Mucocutaneous border of lower lip excised and pulled through cheek incision with stay sutures

Figure 21; Steps in anti-drool cheiloplasty.





Horizontal mattress sutures attaching mucosal flap to upper lip (a) and oversewn with simple interrupted pattern (right). Bold arrows indicate stay sutures.

Satisfactory postoperative appearance with reduction in excessive drooling.

Figure 22; Results of antidrool cheiloplasty.

3.4 DENTAL EXAMINATION IN DONKEYS

One thousand, two hundred and eleven donkeys were recruited through KSPCA clinics with consent from owners at Karen-Langata, Bomet, Nyahururu, Mweiga, Naivasha, Naromoru, Maai-mahiu and Limuru.

3.4.1 CLINICAL EXAMINATION

Donkeys with dental conditions were subjected to thorough dental examination and the findings recorded in Modified Triadan recording charts (Appendix 2). Digital photographs of selected cases were also taken.

A complete clinical history of each donkey was obtained from the owner and was recorded in a dental chart. Aspects captured in the questionnaire included the dietary habits, signs of quidding (dropping food from the mouth), head shaking, loss of condition, halitosis and any physical abnormality noted by the owner on the face and/or mouth.

The patients were generally easy to handle, thus obviating the need for sedation to facilitate dental examination. Examination of the buccal edges of the cheek teeth was possible by external palpation through the cheeks. Facial symmetry was noted during this stage and any abnormalities noted. Coaxing the patients by stroking enabled application of a hand twitch on the upper lip, thus facilitating exposure and examination of the incisors. The angle of the bite between the occlusal surfaces was noted to identify conditions such as parrot mouth. Incisors were manipulated to determine whether they were firm within the alveoli or loose especially for deciduous incisors being shed. The mouth was opened to examine the oral structures. The cheek

teeth in particular were exposed and evaluated by grasping the tongue through the interdental space and applying slight pressure with the thumb on the hard palate. Visual inspection of the cheek teeth and oral mucosa was achieved with the aid of a penlight. A McPherson oral speculum was used to facilitate examination of the oral cavity for longer periods and in those patients that resisted manual opening of the mouth (Figure 23).

The oral speculum was however not well tolerated so most examinations were done without it. Without the speculum, conditions affecting the cheek teeth were assessed using the fingers, with the operator's hand inserted in the oral cavity. The index finger was used to assess the edges of the teeth while noting abnormalities such as abnormal wear. The tongue of the patient was held at the labial commissure, preventing closure of the mouth, and thus protected the examiner from bites.

Other materials and equipment found useful during the dental examination of donkeys included; a bucket to hold water used to rinse the mouth and a large dose syringe (60 ml) for flushing the mouth.

Figure 23; Oral speculum use in a donkey.

3.5 INTERVENTIONS FOR DENTAL CONDITIONS IN DONKEYS

Intervention procedures were based on findings from history and clinical dental examination. All interventions were done with the patient under physical restraint. This was achieved by application of a hand twitch that involved grasping the upper lip. In cooperative patients gentle coaxing was done and the head cradled by passing one hand under the lower jaw as the operator opened the oral cavity for dental work. Any trapped pieces of hay and grain were dislodged from between the teeth and gums.

3.5.1 FLOATING / DENTAL RASPING

This was done using manual dental rasps to correct abnormal wear patterns. The conditions included; wavemouth, sharp enamel edges, step mouth and premolar hooks. The aim was to grind the crowns of cheek teeth to levels that removed sharp enamel points, focal or generalized irregularities on the occlusal surfaces to achieve normal occlusion.

The floats/dental rasps used were fitted with tungsten carbide planing blades (Figure 24). An angled/offset rasp was used for the upper premolars and molars. The lower premolars and molars were floated using a straight float. The rasps were dipped in a 1% solution of iodine during the procedure. This solution was held in a 5-liter plastic container with a narrow mouth. This allowed for rinsing of the float tips without excessive noise to scare the patients. The container was also unbreakable. The tongue was grasped and extruded to keep the mouth open during rasping. Before rasping commenced, a 30ml syringe was used to flush the oral cavity with plain water. The water removed feed material sufficiently to allow for efficient floating, as feed

interfered with contact between the float tip and the teeth. This was preferred to using dilute iodine solution since there was a chance of swallowing by the patient. On average, approximately 10 to 20 strokes of the rasps were required to achieve correction of the focal irregularities on the dental arcades. Wave mouth and step mouth required more time and more strokes to correct sufficiently, as compared to sharp enamel edges and hooks.

While rasping, the tips of the rasps were rinsed in dilute iodine to remove enamel grit and feed material. During this time, palpation of the teeth was done to determine progress. Care was taken to avoid injury to the buccal and lingual mucosa by ensuring that the head was firmly restrained and that steady pressure was applied on the teeth surfaces during rasping.

Depending on the area of interest, the rasp was held either by the handle, as when floating the caudal molars, or by the shaft near the tip as when rasping off the upper premolar hooks. This ensured precision and control over the degree of grinding achieved. The sharp lingual or buccal edges were first rasped blunt, then the rasp oriented to conform to the natural slant of the corresponding arcade to remove abnormal irregularities on occlusal surfaces. Care was taken not to over-correct these irregularities by floating the occlusal surfaces smooth.

After each floating episode, occlusion was determined by lateral excursion of the jaw. This was judged with the mouth shut and the incisors held in occlusion as the mandible was manually moved from side to side. Manual retraction of the lips

allowed for visual inspection. The aim was to achieve free lateral excursion to either side, without loss of contact between the incisor arcades.

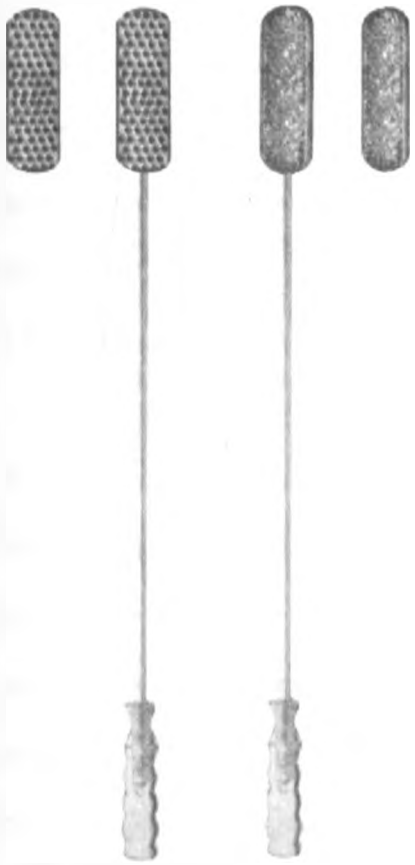


Figure 24; Equine dental rasps with interchangeable inserts. Tungsten carbide insert shown on the right. (Bontempi s.n.c – Italy)

3.5.2 EXTRACTION

Dental extraction was performed for loose teeth, shedding incisors, persistent deciduous incisors and enamel caps. The aim was to remove any shedding incisor whose exposed root was causing injury to oral mucosa or whose presence was impeding normal eruption of the corresponding normal incisor. Shedding incisors were removed by gentle twisting of the tooth, grasped between the index finger and

thumb. There was minimal resistance encountered in all incisors extracted since they were attached by small bits of gingiva.

Enamel caps were removed by prying them from the crowns of cheek teeth using a flat tipped screwdriver. Some came off while floating teeth. The tip of the dental float was also used to remove caps by applying a sharp tap against the handle with the tip held against the cap. After extractions, the oral cavity was sanitised by irrigating with dilute betadine.

3.5.3 ORAL SANITIZATION

Oral ulcers due to irritation by roots of shedding incisors, necrotising stomatitis and traumatic cheilitis were all treated by topical antisepsis. The mouth first flushed with water using a large syringe (30 ml) to remove feed material and other debris. Then a cotton swab dipped in 1% iodine solution was used to clean the surface of ulcers, removing any loose necrotic material manually. This was followed by liberal irrigation of the oral cavity using the same solution. This was also dispensed for the owner to continue treatment at home for at least five days.

CHAPTER FOUR

4.0 RESULTS

4.1 CANINE STUDY

A total of **68** out of **235** patients representing **28.9%** had various dental conditions. The conditions observed during the dental examination and radiology were classified into three depending on the following three categories; Periodontal conditions, Endodontic conditions and Miscellaneous conditions and signs associated with dental disease.

4.1.1 PERIODONTAL CONDITIONS

The frequency of periodontal conditions in **68** dogs is presented in Table 1. The most frequent periodontal conditions were; dental plaque (**89.7%**), gingivitis (**76.5%**), halitosis (**69.1%**), and dental calculi (**64.7%**). Periodontitis (**35.1%**), gingival recession (**25.0%**), periodontal pockets (**23.5%**) and mobile teeth (**16.2%**) were less frequently observed.

Table 1; Percentage of Periodontal Conditions in 68 Dogs

CONDITION	CASES OUT OF 68	PERCENTAGE
Dental plaque	61	89.7
Gingivitis	52	76.5
Halitosis	47	69.1
Dental calculi	44	64.7
Periodontitis	24	35.3
Gingival recession	17	25.0
Periodontal pockets	16	23.5
Mobile teeth	11	16.2

4.1.1.1 DENTAL PLAQUE

Dental plaque was the most frequently observed periodontal condition (89.7%) and was manifested as a thin, sticky film on the surface of teeth, imparting an irregular shiny appearance. Yellow discoloration of plaque commonly occurred near the free gingival margin, especially when dental calculi was present. Although plain water did not dislodge plaque deposits from surfaces of affected teeth, dilute hydrogen peroxide foamed slightly on contact with the plaque. Dilute iodine stained plaque light brown or yellow and this was a good indicator of plaque residues in dental prophylactic procedures. The substance was closely adherent to the enamel surfaces of involved teeth requiring the use of dental scalers to dislodge it. Dental plaque was also recovered from the gingival sulcus on probing using a periodontal probe, or shepherd's crook dental explorer. The most severe form was grossly visible deposition of plaque. On the other hand, mild deposits were visible after staining with dilute iodine or showed foaming on application of dilute hydrogen peroxide. Dental plaque was accompanied by hyperemia of the free gingival margin and an increased depth of the gingival sulcus, as determined by a periodontal probe or a shepherd's crook dental explorer.

4.1.1.2 GINGIVITIS

Gingivitis occurred in 76.5% of dogs and was characterized by a change in color from a healthy pink to reddening (hyperemia), starting at the free gingival margin and extending towards the mucogingival junction. However, this was difficult to judge in dogs with pigmented gums. Thickening of the free gingival flap and loss of contact between the free gingival margin and the enamel surface was noted as bulging of the free gingival margin. Ultimately, it resulted in excessive coronal proliferation of the

gingiva with irregular outlines. Other cases had pedunculated richly vascularised flaps of hyperplastic gingiva (Figure 18). Additionally, there was deepening of the gingival sulcus as result of detachment of the attached gingiva from the tooth neck at the cemento-enamel junction. Additional signs of gingivitis included gums that bled easily on slight probing with a dental explorer or periodontal probe. In the presence of periodontitis, gingivitis was most severe and was associated with gingival recession exposing the root surfaces, as well as furcation involvement for multiple root teeth (Figure 25). Gingivitis was often associated with dental plaque, dental calculi and halitosis.

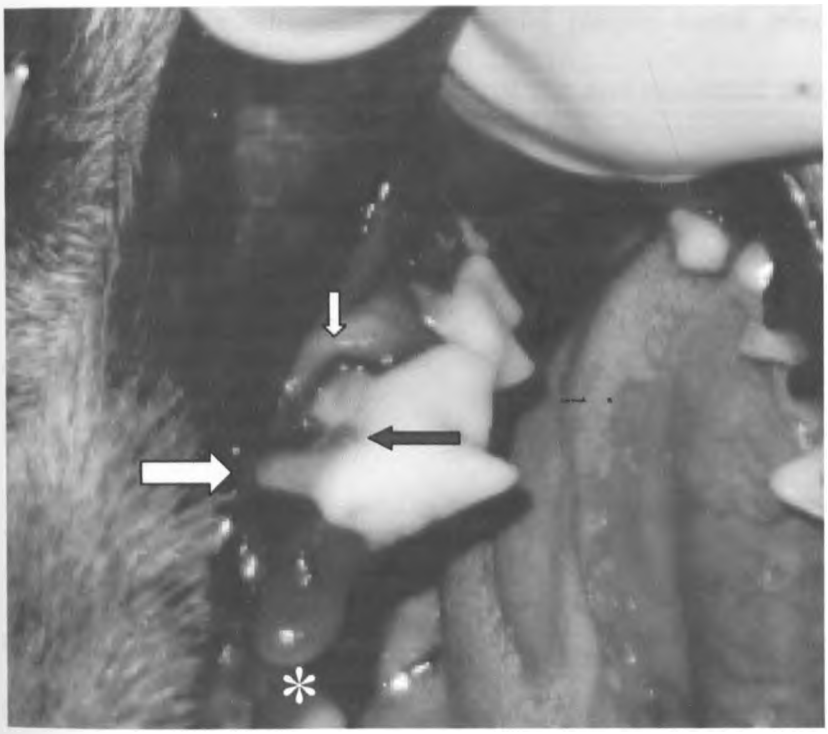


Figure 25; Gingival recession with tooth root (white arrows) and furcation (blue arrow) exposure. Asterix shows hyperplasia of gingival margin.

4.1.1.3 HALITOSIS

Halitosis (oral malodor) was observed in 47 out of 68 dogs (69.1%). It was the primary complaint by the owners seeking treatment for their pets in 2 out of the 47 dogs. In mild cases, oral odor was hardly detectable unless one faced directly into the path of exhaled air. This was also the case if the oral cavity of the patient was opened during examination, with the investigator's nose near the mouth of the patient. Halitosis was also detectable during dental procedures in anesthetized patients that required close proximity of the investigator to the patient's oral cavity. Severe malodor was detectable about 2-3 meters away from the patient, as was the case in one patient with an extensive oral tumor. Oral malodor was more severe in patients with concurrent conditions such as dental plaque, dental calculi, gingivitis and periodontal disease. Trapped food material was also associated with the occurrence of halitosis. One patient with terminal renal failure showed ulcerative gingivitis and halitosis.

4.1.1.4 DENTAL CALCULI

Dental calculi was observed in 64.7% of the dogs and characterized as cream, yellow or brown mineralized deposits that had rough surfaces and were firmly attached to affected teeth. The surface area of the crown covered in calculi, varied from deposits affecting less than one third of the tooth surface to calculi that covered the entire crown. The deposits invariably started at the gingival margin and grew coronally. In some cases, calculi deposits were found impinging on the free gingival margin causing distortion.

Further examination during dental prophylactic procedures revealed sub gingival deposits extending under the gum to affect the root. The calculi deposits occurred most commonly in the upper premolars and molars, with the most commonly affected tooth being the upper carnassial. There was marked hyperemia on the free gingival margin at the point of contact with dental calculi. Furthermore, the large deposits of sub gingival calculi were often associated with gingival recession. Figure 12 shows a carnassial tooth covered with calculi and marked hyperplastic gingivitis. The same tooth after scaling is seen with exposed roots and furcation in Figure 18. The surface of the dental calculi was covered by a film of dental plaque in most of the cases examined.

4.1.1.5 PERIODONTITIS

Periodontitis (periodontal disease) was defined as the inflammation of any two of the structures associated with the tooth i.e. the gingiva, periodontal ligament, cementum and alveolar bone. It was observed in 24 out of 68 dogs examined (35.1%). Gingivitis was noted as hyperemia with reddening and thickening of the gingiva. In extreme cases, hyperplasia or gingival recession was noted (Figure 18). Detachment of the gingiva from the cemento-enamel junction with deepening of the gingival crevice apically was measured using a periodontal probe. Most cases with periodontitis recorded a probing depth was more than 5mm while in some cases the probing depth was markedly reduced due to gingival recession. In some cases the gingiva receded apically to expose the root with its covering layer of cement (Figure 25). Change in color of the cementum to dark brown or black was noted in some cases indicating necrosis of the cementum covering the exposed root (Figure 26). Severe gingival recession exposed the furcation in two or three root teeth (Figure 25). Loosening of

teeth within their sockets was a clinical indication of involvement of the periodontal ligament and/or alveolar periosteitis with bone loss in severe cases of periodontal disease.

Figure 26; Severe periodontitis with exposed incisor roots (tip of instrument). Necrotised cementum appears dark.

4.1.1.6 GINGIVAL RECESSION

Apical retraction of the free gingival margin following detachment from the cemento-enamel junction was observed in 17 out of 68 dogs (25.0%). The condition was associated with severe gingivitis, excessive deposition of sub gingival calculi and advanced periodontal disease (Figure 18). Exposure of the tooth root changed the color of the cementum to dark brown or black due to necrosis (Figure 19). The periodontal probing depth was less than 2mm.

4.1.1.7 PERIODONTAL POCKETS

Deepening of the gingival sulcus due to trapping of food debris, accumulation of plaque or calculus was observed in 16 out of 68 dogs examined (23.5%). It was often associated with severe periodontal disease. Diagnosis of the condition was made

during sub gingival scaling in dental prophylactic procedures, after debris or dental calculus was removed from the gingival crevice. Sub gingival probing depth was of more than 2mm.

4.1.1.8 MOBILE TEETH

Mobile teeth were diagnosed in 11 out of 68 of dogs examined (16.2%). Loose teeth moved within their sockets when a horizontal force was applied with a finger. Digital pressure dislodged a premolar from its socket in a patient with advanced periodontitis. In some cases, maxillary and mandibular incisors were slightly mobile on application of digital pressure, even without an obvious pre-existing dental condition. Tapping on teeth crowns with the handle of a dental probe elicited dull resonance from loose teeth due to reduced transmission of the sound to the supporting structures.

4.1.2. ENDODONTIC CONDITIONS

The distribution of endodontic conditions observed in the 68 dogs is presented in Table 2. The most common conditions were pulp exposures (32.4%), fractured teeth (20.6%) and dental caries (19.1%) some showing radiographic changes (17.6%). Missing teeth (7.4%) and dental fistulas (2.9%) occurred infrequently.

Table 2; Distribution of Endodontic Conditions from 68 Dogs

CONDITION	CASES OUT OF 68	PERCENTAGE
Pulp exposure	22	32.4
Fractured teeth	14	20.6
Carious teeth	13	19.1
Radiographic changes	12	17.6
Missing teeth	5	7.4
Dental fistula	2	2.9

4.1.2.1 PULP EXPOSURE

Pulp exposure is caused by trauma or natural attrition of the teeth on occlusion. It was exhibited in 22 of the 68 dogs examined (32.4%). Of the 22 dogs with pulp exposure, 14 (63.6%) involved the canine teeth, 7 (31.8%) involved the incisors and only 1 (4.5%) had pulp exposure in the premolars.

Acute pulp exposure was associated with bones in the diet of two cases seen. Two of the dogs were examined three days following trauma, which appeared as splinter fractures of the crown enamel and dentine of the canines. The third dog had no history associated with the fractured canine that was also splintered. The two cases presented within seven days of trauma had hemorrhage within the exposed pulp. In older fractures the dentine had dark brown staining associated with pulp hemorrhage. The tooth was also mobile within its alveolus, with the crown split into two longitudinal fragments. Pulp exposure due to gradual wear of the enamel and dentine resulted in darkening of the center of the occlusal surface, due to reparative dentine.

4.1.2.2 FRACTURED TEETH

Tooth fractures were encountered in 20.6% of cases. These varied from superficial enamel chipping exposing the dentine, to complete fissures with separation extending from the surface enamel through to the underlying dentine, to expose the pulp cavity. Fractured teeth were associated with biting onto a metallic dogcatcher rod in one patient being used for non-emergent surgical procedures. The affected teeth in this case were the premolars. Fractures were most commonly observed in the canines representing 11 (78.6%) out of 14 of patients with teeth fractures. Two (14.3%) out of 14 cases had fractures involving the incisors while only one (7.1%) case out of 14 had fractures involving the premolars.

4.1.2.3 DENTAL CARIES

Dental caries affected 19.1% of patients and commonly involved the premolars. Caries were less frequently encountered in canines, incisors and molars. The common site affected was the buccal surface of the premolars, near the gingival margin. Dental caries were also encountered on the occlusal surface of molar teeth in one patient. Caries appeared as dark focal surface irregularities. Probing the tooth surface with a dental explorer elicited a gritty feeling when caries were encountered. Caries on mandibular canines occurred on the distal and mesial surfaces, especially on the points of occlusal with the maxillary canine and corner incisor. Caries on maxillary canines, however, occurred predominantly on the distal surface. Caries affecting the incisors, on the other hand, appeared on the lingual surfaces near the gingival border. None of the caries encountered affected the full thickness of the enamel and dentine on probing with a dental explorer.

4.1.2.4 MISSING TEETH

Missing teeth were encountered in 5 out of 68 dogs examined (7.4%). Loss of premolars and incisors was attributed to periodontal disease in four patients. Missing mandibular premolars on the right jaw in one patient was due to lack of eruption. Figure 27 shows missing incisors due to periodontal disease.

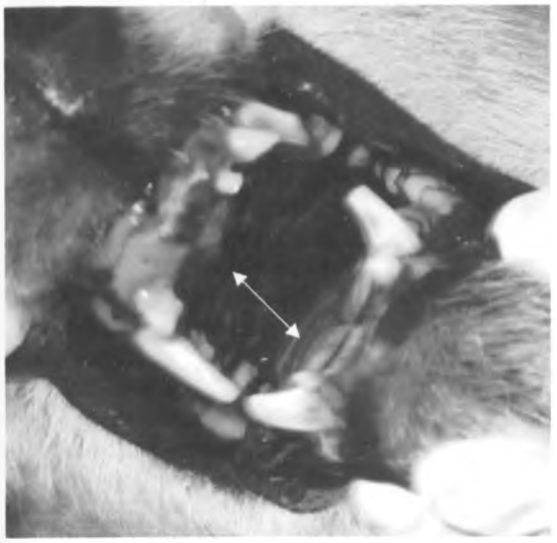


Figure 27; Missing incisors due to periodontal disease.

4.1.2.5 DENTAL FISTULA

Dental fistulas were observed in only 2 dogs (2.9%). The first case was associated with extensive oral neoplasia of the right maxilla, resulting in loss of the premolars and carnassial tooth on that side. The vacant alveolus left by the lost carnassial tooth in this case had left a deep fistula that exuded fetid purulent discharge. The second case exhibited a fistulous tract connecting the skin under the left eye and an infected deciduous carnassial on the maxilla (Figure 28).

Figure 28; Exit of a sinus tract from an infected maxillary carnassial.

4.1.3 MISCELLANEOUS DENTAL CONDITIONS

The distribution of miscellaneous conditions and signs associated with dental conditions in 68 dogs examined are presented in Table 3 and include; regional lymphadenopathy, soft tissue trauma (due to malaligned teeth impinging on opposing gums and soft tissues), brachygnathism, alterations in extra oral structures, oral tumors and glossitis. Other alterations involving teeth were; malaligned teeth, retained deciduous teeth and supernumerary teeth.

Table 3; Miscellaneous Conditions and Signs Associated with Dental Conditions in 68 Dogs

CONDITION	CASES OUT OF 68	PERCENTAGE
Lymphadenopathy	6	8.8
Malaligned teeth	5	7.4
Trauma on soft tissues*	4	5.9
Brachygnathism	4	5.9
Retained deciduous teeth	4	5.9
Altered extra oral structures	4	5.9
Oral tumors	2	2.9
Glossitis	2	2.9
Supernumerary teeth	1	1.5

Key;

* due to malaligned teeth.

4.1.3.1 LYMPHADENOPATHY AND TONSILITIS

The tonsils were inflamed and visible outside their crypts (Figure 29) in three cases, while in three other cases, the sub mandibular lymph nodes were enlarged (Figure 30). Enlarged sub-mandibular lymph nodes and tonsillitis occurred concurrently with glossitis in two cases.

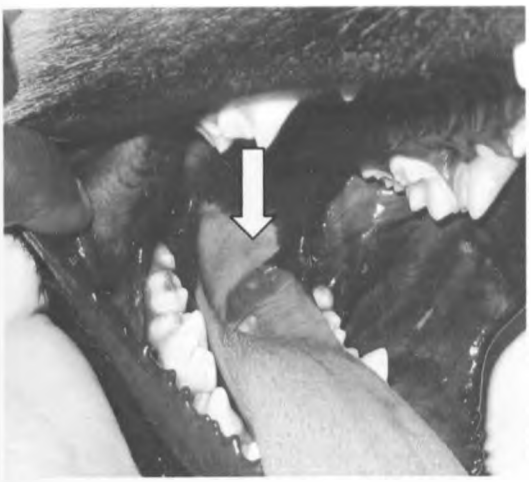


Figure 29; Inflamed tonsil visible outside the tonsilar crypt (white arrow).

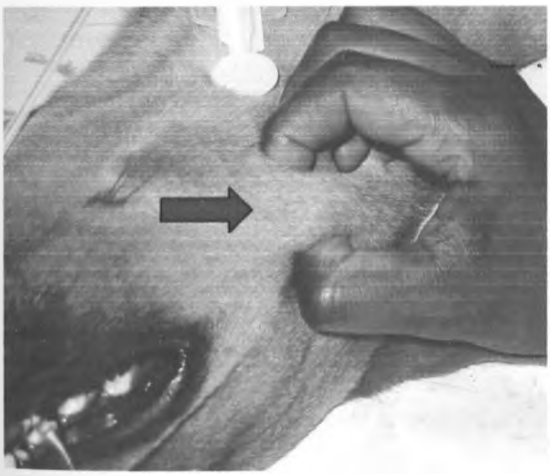


Figure 30; Lymphadenopathy of submandibular lymph node (blue arrow) patient is in dorsal recumbency.

4.1.3.2. MALALIGNED TEETH

Teeth malalignment was characterized by the distortion of dental arcades viewed from the occlusal surfaces. The condition was congenital in 2 out of 5 cases. In the other two cases out of 5 diagnosed with malalignment, it was due to retained deciduous canines. In one dog malalignment was due to malunion of a mandibular ramus fracture (Figure 31).

Figure 31; Malaligned mandibular canine due to malunion of mandibular fracture.

4.1.3.3 BRACHYGNATHISM

Of the four cases exhibiting this condition, mandibular brachygnathism (shortening of the lower jaw) was seen in two cases (Figure 32). This was accompanied by malocclusion with impingement and injury on the opposing hard palate. One dog with mandibular brachygnathism showed excessive drooling. Maxillary brachygnathism (shortening of the upper jaw) was observed in two cases.

Figure 32; Congenital mandibular brachygnathism in an adult Alsatian dog.

4.1.3.4 RETAINED DECIDUOUS TEETH

Retention of deciduous incisors was encountered in two out of four cases. One of these cases had retained central incisors on the lower jaw. Another case had a retained premolar, while one case had retained deciduous canines (Figure 33). This condition was a cause of malalignment and soft tissue trauma.

Figure 33; Retained deciduous mandibular canine.

4.1.3.5 ALTERATIONS IN EXTRA-ORAL STRUCTURES

These alterations included submandibular swelling in one case with glossitis and a sub-ocular facial swelling in a case with a dental fistula located just below the lateral canthus of the left eye. Asymmetry of the muzzle in a patient with an odontogenic tumor of the incisive bone was also observed (Figure 34). Cheilitis characterized by reddening and encrustations on the lip commissures was diagnosed in a patient with a habit of carrying an aluminum plate in her mouth during feeding times.

4.1.3.6 ORAL NEOPLASIA

Oral neoplasms were encountered in 2 cases. One case was an infected squamous cell carcinoma of the gum with extensive damage to the maxilla and loss of teeth. The other was an odontogenic tumor of the incisive bone and maxilla (Figure 34). This resulted in facial asymmetry, distortion of the hard palate and absence of the left upper corner incisor. Post mortem examination revealed metastasis to the lungs, kidneys liver and spleen.

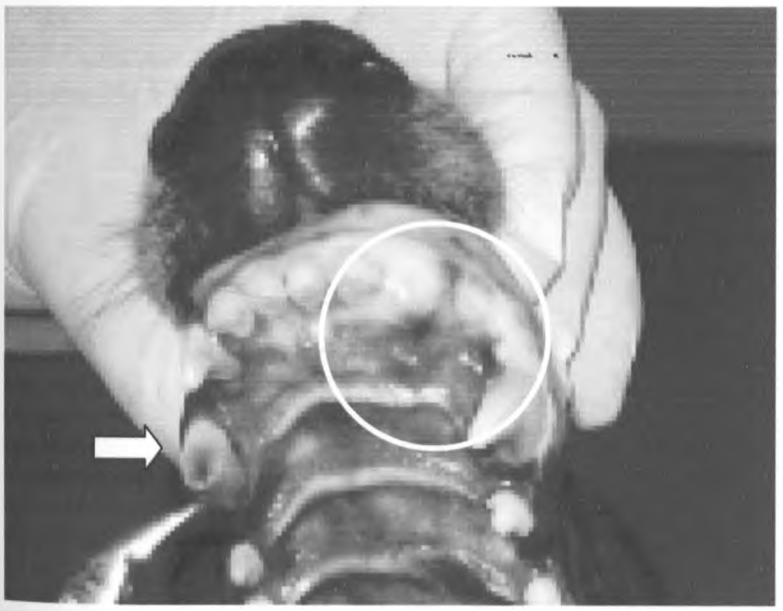


Figure 34; Odontogenic tumor of the incisive bone with asymmetry and absence of corner incisor (circled). Broken canine with dark reparative dentine (arrow).

4.1.3.7 GLOSSITIS

Glossitis was encountered in only two cases. The first case had extensive swelling of the sub-mandibular region. The patient was unable to close the mouth and was hypersalivating due to severe swelling of the tongue and frenulum (Figure 35). The frenulum was edematous. The other patient was drooling bloody saliva and was also unable to close the mouth. The tongue was markedly swollen and had a circumscribed region of cyanosis at the center of which was a necrotising infection with hemorrhage. Both cases had tonsilitis, characterized by hyperemic tonsils visible outside the tonsilar crypts (Figure 29).

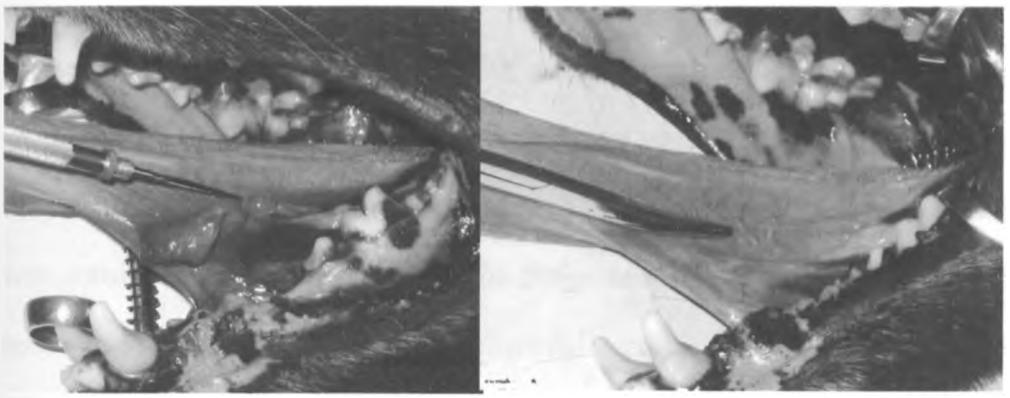


Figure 35; Glossitis (left) and after successful medical treatment (right).

4.1.4 DENTAL RADIOGRAPHY

Dental radiology was performed in twelve dogs with periodontal disease and oral neoplasia. This was done under general anaesthesia and conventional x-ray equipment was used (Figure 7). Dental radiographs were obtained with 55kVp, 10mAs and a focal length of 40 cm. Radiology was done to evaluate sub gingival structures and in cases with oral tumors.

4.1.4.1 DETERMINATION OF EXPOSURE FACTORS FOR DENTAL RADIOLOGY

Mosquito hemostatic forceps were placed on top of the radiographic film and different exposure factors used to determine the ideal image after processing. Optimum radiographic contrast was achieved with a focal length of equal or less than one centimeter 60 kVp and 10 mAs after five exposure trials. A focal length of ≤1cm, as used with dental x-ray equipment, would have been ideal but this was achieved only with considerable difficulty owing to the design of the mobile x-ray unit head. This necessitated adjustment to achieve optimum radiographic contrast at a focal length of 40cm and kVp adjusted to 55. Table 4 outlines the exposure factors used to determine optimal radiographic quality of the dental radiology study in dogs.

Table 4; Determination of Optimal Exposure Factors for Dental Radiology using Practix® Mobile X-ray Unit

TRIAL	1	2	3	4	5
EXPOSURE FACTOR					
kV	45	60	60	60	55
mAs	5	5	10	10	10
FOCAL LENGTH	100	10	≤1	50	40
RADIOGRAPHIC CONTRAST	Poor	Poor	Good	Fair	Good
DIAGNOSTIC QUALITY	Minimal	Minimal	Good	Fair	Good

The fifth trial had good radiographic contrast, good diagnostic quality and was practical since the x-ray head did not have to contact the patient during exposure.

4.1.4.2 RADIOGRAPHIC FINDINGS

Normal radiographic findings were determined following the assessment of the radiological status of the structures as outlined below.

The enamel appeared radiodense albeit non-uniformly due to the varying surface relief of teeth. The dentine lying immediately below the enamel appeared less dense than the enamel. The pulp cavity appeared as a large radioluscent space in young dogs, and decreased in size in older patients. In dogs over ten years of age, the pulp cavity was not visible. The lamina dura appeared as a continuous radiodense outline of the cortical bone lining the alveoli, surrounded by cancellous bone of variable radiodensity. The radioluscent space between the tooth root and the lamina dura represented the periodontal ligament (Figure 37). The maxillae are paired bones found to the left and right of the midline. They lie between the incisive bone rostrally

and frontal bones caudally, and appeared radiodense against a radioluscent background due to the nasal passages and the cartilaginous nasal septum. The vomer also formed a v-shaped radiodense region in the midline between the maxillae. The ventro-lateral margins of the maxillae were radiodense, since they contain the alveoli for the upper teeth except, the incisors. The incisive bone is rostral to the maxillae and contains the alveoli for the incisors. In ventro-dorsal open mouth radiographs, the midline over the incisive bone showed linear radiodensities, representing the palatine fissures.

The dorsal portion of the mandibular body contains the alveoli for mandibular teeth. Lateral open mouth oblique radiographs revealed a continuous radioluscent zone running below the alveoli. This represented the mandibular canal within which is blood and nervous supply to teeth roots. The middle mental foramen appeared as a radioluscent zone intersecting the mandibular canal outline ventral to the root of the first mandibular premolar. This is an important landmark when interpreting dental radiographs.

Fractures of teeth and supporting bone were assessed by using conventional screen radiographs and intra-oral non-screen radiographs. Bone fractures were, however, not diagnosed. The radiographic features of teeth fractures include; loss of the crowns, linear defects on the crowns, longitudinal defects affecting the crown and root and extending towards the apex, and transverse displacement of teeth crowns and/or roots.

Infectious or inflammatory processes evaluated using dental radiography included gingivitis and periodontal disease, which were common conditions in this study. No

radiographically significant changes were evident in the periodontal ligament, the lamina dura and associated bony structures in acute disease. However, chronic cases were characterized by loss in outline of the lamina dura and distortion of the space representing the periodontal ligament. The common sites for these changes were at the cemento-enamel junction, between adjacent teeth, and between roots of the same tooth (crestal bone loss). Long standing periodontal disease was manifested by radiodensity of bone around the alveoli. Dental caries appeared as radioluscent defects at the cemento-enamel junctions.

Regional osteomyelitis associated with severe periodontal disease was represented by local soft tissue swelling and periosteal new bone formation with destruction of underlying bone. Radiographic changes due to neoplasia were seen in two cases. Local infiltrations of the tumors caused thinning and apparent elongation of tooth roots within affected bones. Periosteal new bone formation, destruction and displacement of teeth roots within the alveoli and teeth loss were also evident. The locally invasive neoplasms caused distortion of the maxilla and incisive bones. One case with an odontogenic tumor had a missing upper left corner incisor due to non-eruption.

Dental radiographic features of sub gingival changes associated with periodontal disease included; loss of outline of the periodontal ligament space, truncated crowns due to attrition with exposure of the pulp cavity and displacement of teeth within their alveoli due to loosening of the periodontal ligaments. In addition, there was bone loss at the cemento-enamel junctions, crestal bone loss between roots of the same tooth, and root exposure secondary to gingival recession (Figure 36).

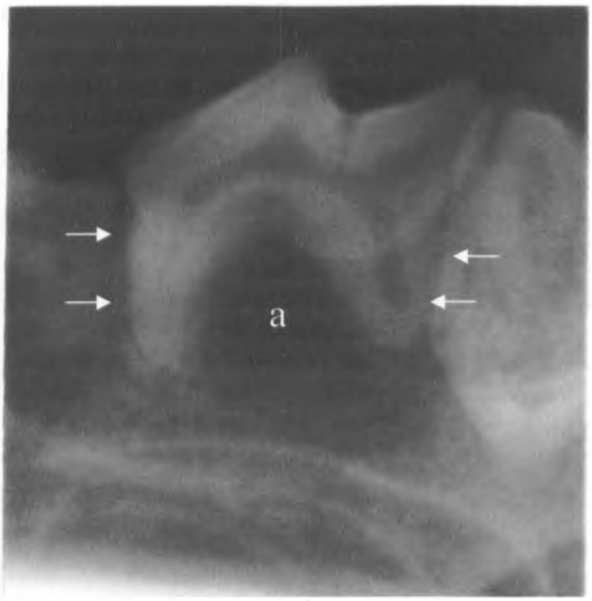


Figure 36; Intra-oral radiograph of a mandibular carnassial showing crestal bone loss (a) and loss of the periodontal ligament space (arrows). Lamina dura is not clear.

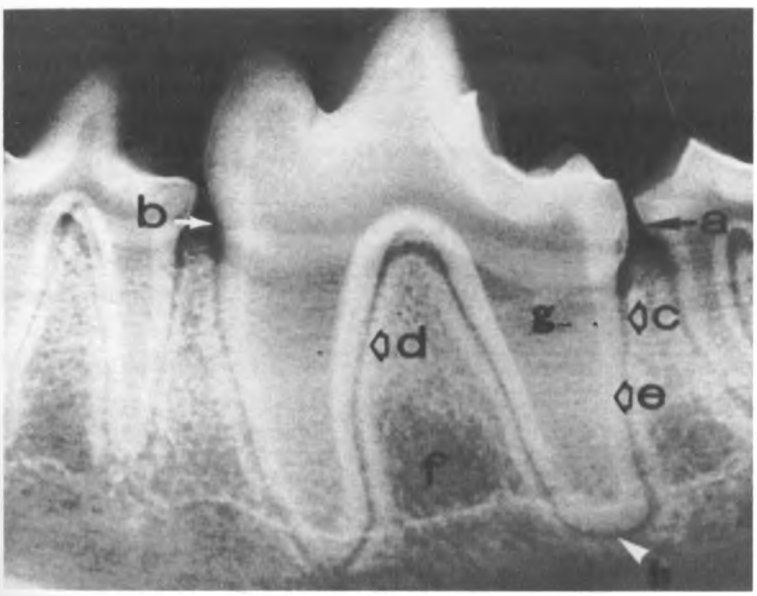


Figure 37; Radiograph of normal teeth. Tubercle of the crown (a), cemento-enamel junction (b), periodontal space (c), lamina dura (d), cementum (e), cancellous bone (f), pulp cavity (g) and the apex (h).

4.1.5 DENTAL INTERVENTIONAL PROCEDURES

Dental intervention procedures were performed based on the nature of the dental condition and available dental equipment. These interventions were classified as dental surgery and included extractions, restorative cheiloplasty and antidrool cheiloplasty. Periodontal treatment involved dental prophylaxis (scaling), manual polishing, sub gingival curettage (root planing) and gingivectomy. Medical treatment was done by topical oral antisepsis, using dilute hydrogen peroxide or dilute Betadine. Systemic antibiotic treatment was done with amoxycillin trihydrate (Betamox®, Norbrook Laboratories Ltd., Newry Co. Down, Northern Ireland) at 15mg/Kg body weight, intramuscularly and/or metronidazole (Metronidazole 200mg BP, Medopharm, Chennai, India) at 30mg/kg body weight orally. The various dental interventional procedures and frequency of patients subjected to them are summarized in Table 5.

Table 5; Frequency of Dental Intervention Procedures carried out in Dogs

TREATMENT	FREQUENCY
Dental prophylaxis	28
Manual polishing	28
Topical oral antisepsis	28
Antibiotic treatment	21
Sub gingival curettage	10
Extractions	5
Gingivectomy	4
Restorative cheiloplasty	1
Antidrool cheiloplasty	1

Periodontal treatment was the most commonly done, followed by surgical procedures and medical treatment. Medical treatment was considered the primary intervention if it was not done as adjunctive to other procedures such as periodontal treatment or oral surgery.

4.1.5.1 PERIODONTAL TREATMENT

4.1.5.1.1 DENTAL PROPHYLAXIS

This primarily involved the manual removal of dental calculus and plaque, both supra gingival and subgingival. Basic instruments used were hand held dental scalers, curettes, files and hoes. Scalers were most useful for removal of supra gingival calculus and plaque. The curette and hoe were most useful for removal of sub gingival calculi. Periodontal files were used for manual polishing of the root surfaces after removal of sub gingival calculus by the curette and hoe.

Manual scaling involved the initial removal of gross calculus deposits using the jaws of a Mayo-Hegar needle holder. The jaws of this instrument were closed firmly over the deposits to break them off, or loosen them for removal with dental instruments. A shepherds crook supragingival scaler was then used to remove visible calculi deposits from the crowns, by use of coronal strokes starting from the neck towards the tip of the crown. Although care was taken not to injure the gingiva, bleeding occurred in cases with gingivitis. Using the back of the curved tip of the shepherd's crook scaler gave the best results when working on the surface of the crowns. The sharp tip of the scaler was useful for removal of calculus between adjacent teeth. Dental curettes were used for removal of subgingival calculi with minimal iatrogenic injury to the gingiva, since they have two cutting edges compared to three in the supra gingival scaler. The

convex side of the tip of the dental curette was oriented towards the gingiva during removal of sub gingival calculi, and coronal strokes used to dislodge the debris. The shepherd's crook supra gingival scaler also gave good results in removing subgingival calculi by careful manipulation within the gingival sulcus especially in cases that had gingival recession. However, this took more time compared to when dental curettes were used. The removal of dental calculi and polishing of exposed root surfaces is detailed under root planing/curettage.

In the use of hand held instruments, the success of the procedures depended on the position of the instruments to contact the surfaces of the teeth and provision of firm pressure by the index finger and thumb with the little finger providing a fulcrum usually against another tooth or the gum.

4.1.5.1.2 SUB GINGIVAL CURETTAGE (ROOT PLANING)

Subgingival curettage was done to remove sub gingival plaque, calculus, food debris and inflamed epithelium from gingival crevices and root surfaces, using a subgingival curette. The dental curette was introduced into the gingival sulcus and the cutting edge of the instrument engaged onto the root surface. With the tool firmly held against the root, coronal strokes were employed to scrape the surface. The process was repeated to cover the entire surface of the root, and then root planing done. Root planing is the smoothening of root surfaces using a dental hoe or curette. The procedure was used to remove necrotic cementum from the surfaces of exposed roots. The strokes were also done in all direction to achieve a smooth root surface.

4.1.5.1.3 MANUAL POLISHING

Following removal of supragingival and subgingival calculi, the back of a dental curette was used to achieve manual polishing. Subsequently a toothbrush with firm nylon bristles was applied firmly to the surfaces of the teeth in a circular motion. The oral cavity was continuously cleaned with gauze swabs soaked in dilute hydrogen peroxide then rinsed with plain water to remove debris.

4.1.5.1.4 GINGIVECTOMY

This is reconstructive periodontal surgery of the diseased gingiva by excising excess gingiva to obliterate gingival pockets. The indications for the procedure were sulcular depths of more than 5mm and gingival hyperplasia. The objective of the procedure was to resect the free gingival margin leaving approximately 3-4mm of attached gingiva.

A No. 15 Bard Parker blade was placed in a shallow angle to the surface of the gum and firm pressure applied until the tip contacted the tooth. This was repeated in an overlapping pattern to free the portion of the gingiva to be removed. The incisions were made to approximate the natural contours of normal free gingival margins. Bleeding was controlled by digital pressure with a cotton gauze swab over the gingivectomy incisions. Where defects were large, suturing was done with fine monofilament nylon or polyamide suture as earlier described.

4.1.5.2 ORAL SURGERY

4.1.5.2.1 EXTRACTIONS

Extraction was indicated for supernumerary teeth (Figure 38), retained deciduous teeth, fracture extending from crown to root, teeth with non-viable roots and teeth with excessive mobility.

Extractions were done under general anaesthesia as previously described. In one geriatric patient (a Dachshund bitch over 13 years of age), extraction of a fractured canine was done under sedation with xylazine hydrochloride (Xylazine 20 Inj., Kepro, Holland) at 0.5 mg per kilogram body weight.

The teeth most commonly extracted were deciduous canines. However, the close proximity to erupting permanent canines allowed for manipulation only from the side away from the erupting tooth. The periodontal ligament was first luxated using a dental luxator. A luxator with a triangular cross section lent itself well for this function. This instrument was inserted through the gingival crevice and along the root as deep as it would go, and then rotated through 360° or more until free movement was achieved. This was repeated sequentially around the root avoiding the side on which the permanent tooth was erupting. This was to avoid damage to the periodontal ligament and the root of the erupting tooth. Using dental extractors, the tooth was rotated along its long axis and judgment made on satisfactory luxation of the periodontal ligament. Sufficient luxation of this ligament was essential for extraction of the tooth with the complete root. If freedom was not sufficient, further luxation was done using the dental luxator as described. A cup shaped dental luxator was incorporated for luxation since it is bulkier and covered the curvature of the root sufficiently, after initial luxation with a triangular luxator. The freed tooth was

extracted from its alveolus using the dental extractors and examined for completeness of the root. The socket was packed with cotton wool swabs soaked in dilute Betadine to control bleeding.

Extraction of molars and premolars was indicated for teeth with excessive movement within their sockets due to severe chronic periodontal disease. Affected teeth were easy to extract due to their non-viable roots and almost non-existent periodontal ligaments. A triangular luxator was used to free tooth roots from devitalized periodontal ligaments sufficiently enough for extraction with dental extractors by rocking the crowns. Sockets were packed with cotton swabs soaked in Betadine for hemostasis.

Figure 38; Bizarre supernumerary teeth around a mandibular canine (left) and right after extraction.

4.1.5.2.2 RESTORATIVE CHEILOPLASTY

Two dogs underwent reconstructive surgery on traumatic wounds of the lips. Corrective surgery was performed on an adult Rottweiler dog to repair a laceration bite wound on its lip. Functional healing occurred only for half the length of the original laceration following the initial repair, necessitating restorative cheiloplasty. The procedure was performed under general anaesthesia. The purpose was to restore the lip cosmetically and functionally. The initial surgery had been successful in closing the initial defect only partially, due to postoperative wound dehiscence. The result was an unsightly lip margin defect. The restorative surgery involved debridement of the wound margins using a No.22 scalpel blade. The incision was extended away from the lip margin towards normal tissue. Fibrous scar tissue from the initial injury and surgery was excised sufficiently to give fresh wound margins and skin sufficiently undermined to allow approximation and suturing. The margins were approximated manually and contoured appropriately using the blade. Closure was achieved in two layers. The primary layer involved closure of subcutaneous tissue using chromicized catgut No.2-0 in a simple continuous pattern starting from the lip margin. This avoided creating a 'stepped' appearance to the repaired lip margin. The skin over the defect was closed using Nylon No.2-0 in a simple interrupted pattern starting from the lip margin (Figure 20). In the second case routine wound closure was done on a fresh laceration wound on the lip. Debridement and eventual closure was done in a single layer using Nylon No.2-0 in a simple interrupted pattern. The skin sutures were removed in 10 days after cosmetic healing of the wounds in the two cases.

4.1.5.2.3 ANTIDROOL CHEILOPLASTY

Antidrool cheiloplasty is a maxillofacial surgical procedure that corrects the eversion of the mucocutaneous border of the lower lip. This procedure was done to reduce the loss of food and saliva from the lateral vestibules of the oral cavity, and improve aesthetics in a Rottweiler-Doberman cross dog. It had a history of unsightly drooling and excessive drooping of the lower lips with evidence of cheilitis. Pre-operative treatment involved use of metronidazole at 30 mg per kilogram body weight, twice a day for five days orally. Surgery was done under general anaesthesia. Dilute iodine was used as an antiseptic during preparation of the site.

The aim was to create a functional adhesion between the lower lip and the upper lip near the lip commissures. This tucked the margin of the lower lip upwards, thus reducing sagging and excessive drooling. Using the index finger, the lower lip was elevated towards the upper lip so as to make the lower lip margin taut when the mouth was fully open. This gave the guidelines on where the surgery was to be performed to achieve functional adhesion. The point was marked on the skin of the upper lip using the tip of a scalpel blade, corresponding to the root of the upper fourth premolar. An incision was made at this point, starting from an imaginary line drawn from the medial canthus of the eye to the lip commissure, and extended 3 cm rostrally. The incision was full thickness through the skin, subcutis, obicularis oris muscle and the buccal mucosa. A 2mm thickness of tissue, 3cm long, was resected from the margin of the lower lip using a scalpel blade guided by a curved mosquito hemostat, 2 cm rostral to the lip commissure. The edge of the incision was split using a scalpel blade, creating two flaps; one mucosal and the other cutaneous. The flaps were everted and pulled through the incision on the upper lip from the buccal side, using two nylon No.

2-0 stay sutures that were placed at the ends of the flaps (Figure 21). The flaps were then sutured to the incision of the upper lip using a modified horizontal mattress suture with No. 0 Nylon. The cheek skin was apposed with Nylon No.2-0 in a simple interrupted pattern. The procedure was done on both sides of the mouth. Postoperative care by the owner at home involved flushing the oral cavity with plain water using a 30cc syringe to remove food debris after meals. The sutures were removed after 14 days postoperatively. Reduction in excessive drooping of the lower lip and drooling was evident immediately postoperatively (Figure 22) and the client reported marked reduction in drooling over the two weeks healing period.

4.1.5.3 MEDICAL TREATMENT FOR DENTAL CONDITIONS

4.1.5.3.1 TOPICAL ANTISEPSIS

Oral sanitization was done using a solution of 20 volumes of hydrogen peroxide, diluted by an equal amount of water and applied as an oral flush, or with cotton wool swabs. This was indicated for reduction of halitosis due to mild periodontal disease, and also to slow down dental plaque formation following dental prophylactic procedures. When dispensed for home treatment by the owners, it was prescribed for use once daily as an oral flush, with a 10cc syringe. The method was also used satisfactorily for debridement of lesions associated with cheilitis, where the solution was applied topically with cotton wool swabs rubbed firmly on the lesion, before application of diluted iodine. This process was also used adjunctively during dental prophylactic procedures such as scaling. Betadine solution, diluted in equal amounts of water, was used a sanitizer to augment the action of diluted peroxide during dental prophylactic procedures and in preparation for oral surgery.

4.1.5.3.2 SYSTEMIC ANTIBIOTIC TREATMENT

Amoxycillin trihydrate administered intramuscularly at 15 mg per kilogram body weight was used on all patients undergoing dental prophylactic procedures or oral surgery. This was repeated every 48 hours as needed, but two treatments were usually satisfactory. For patients that were not managed postoperatively under admission in the clinic, antibiosis was maintained at 15mg/kg body weight of oral amoxycillin for five to seven days. Metronidazole at 30mg per kilogram body weight orally, twice a day for five days, was indicated for patients with septic oral or lip lesions. Those with ulcerative or severe gingivitis and cheilitis were common candidates.

4.2 RESULTS OF DONKEY STUDY

The frequency of dental conditions in donkeys examined from various locations in Kenya is presented in Table 6.Of the **1,211** donkeys examined during the study, **842 (69.5%)** were male, while **369 (30.5%)** were female; a ratio of **2.3:1.** One hundred and forty nine donkeys, representing **12.30%** were found to have dental conditions and were thus recruited for the study.

TABLE 6; Distribution of Dental Conditions in Donkeys from Various Locations in Kenya

LOCATION	NO.EXAMINED	NO.WITH DENTAL CONDITIONS	PROPORTION %
KSPCA	10	7	70.0
LIMURU	31	12	38.7
MWEIGA	87	26	29.9
NANYUKI	86	21	24.4
NYAHURURU	279	65	23.3
KIAMBU	11	2	18.2
MAAI-MAHIU	37	5	13.5
RUMURUTI	67	8	11.9
BOMET	603	3	0.5
TOTAL	**1,211**	**149**	**12.3**

4.2.1 DENTAL CONDITIONS IN DONKEYS

Dental conditions encountered in the donkey during the study are presented in Table 7. The most commonly encountered dental conditions were wave mouth **(18.8%)**, dental calculi **(12.9%)**, enamel caps **(11.8%)** and incisor conditions **(9.4%)**. Conditions that occurred in moderate frequency included sharp enamel edges **(8.8%)**, dental calculi with gingivitis **(8.2%)**, step mouth **(7.1%)** and hooks on premolars **(7.1%)**. The least common dental conditions were loose teeth **(4.7%)**, discolored teeth **(4.7%)**, swelling on mandible **(1.8%)**, necrotising stomatitis **(1.8%)**, gingival hyperplasia **(1.2%)**, traumatic cheilitis **(1.2%)** and maxillary swelling **(0.6%)**.

4.2.1.1 WAVEMOUTH

Twenty donkeys **(18.82%)** had wave mouth. The condition is an abnormal wear pattern leading to the attainment of a waveform of the dental arcades due to exaggeration of the ridge and valley pattern of the occlusal surfaces. Opposing arcades in affected cases showed alternating lengths measured between the surface of the arcade and the gingival margin. Diagnosis of this condition was done by digital palpation of the dental arcade through the cheeks and on the affected arcade intra-orally. Changes were noted in severely affected cases showing wear extending to the gingival margin. This caused the opposing premolars or molars to lacerate the gingivum. It was noted to occur alongside hooks and steps in some donkeys.

TABLE 7; Frequency of Dental Conditions Observed in Donkeys

CONDITION	FREQUENCY	PERCENTAGE %
WAVEMOUTH	32	18.8
DENTAL CALCULI	22	12.9
ENAMEL CAPS ¥	20	11.8
INCISOR CONDITIONS ±	16	9.4
SHARP ENAMEL EDGES *	15	8.8
DENTAL CALCULI WITH GINGIVITIS	14	8.2
STEP MOUTH	12	7.1
HOOKS ON PREMOLARS	12	7.1
LOOSE TEETH	8	4.7
DISCOLORED TEETH	8	4.7
SWELLING ON MANDIBLE	3	1.8
NECROTIZING STOMATITIS	3	1.8
GINGIVAL HYPERPLASIA	2	1.2
TRAUMATIC CHEILITIS	2	1.2
SWELLING ON MAXILLA	1	0.6
TOTAL	**170**	**100**

¥ - Affecting premolars and molars

± - Includes retained (persistent) deciduous incisors, abnormal eruption, excessive wear, shedding incisors and fractures

* - Involving premolar and molar dental arcades with retention of feed boli in the buccal vestibule of affected side

4.2.1.2 DENTAL CALCULI

Dental calculi presented as yellowish to dark brown or black linear deposits on canines, incisors premolars and molars, near the gingival margins on the labial and the lingual surfaces (Figure 39). The deposits firmly adhered to the enamel of incisors but were less tenacious when found on canine teeth. In **8.2%** of cases dental calculi was associated with gingival margin hyperemia and gingival swelling of varying degrees. In the majority of cases with dental calculi though, gingivitis was not a feature, especially with supra gingival calculi formed on the incisors.

Figure 39; Dental calculi on incisors (blue arrows) and 'parrot mouth' (white arrow).

4.2.1.3 ENAMEL CAPS

Enamel caps are retained deciduous premolars and were observed in 11.8% of donkeys with dental conditions. These were identified as mobile deciduous teeth palpable above the level of the occlusal surface of the corresponding permanent teeth. Freely mobile caps exhibited lateral rotation and could be removed manually. On the

other hand, caps were firmly anchored when the corresponding permanent tooth had not fully erupted.

4.2.1.4 INCISOR CONDITIONS

Conditions affecting the incisors represented 9.4% of dental conditions in donkeys seen and included; retained deciduous incisors, abnormally erupting incisors, excessive wearing, shedding incisors and tooth fractures. Retention of deciduous incisors (Figure 40) involved mainly the corner incisors with the deciduous tooth being commonly found lateral or rostral to the corner incisor. In one patient a retained deciduous incisor caused abnormal eruption of the corresponding permanent incisor. The roots of retained deciduous incisors occupied the same alveolus with the erupting permanent incisor. Retained incisors were freely mobile and were easily dislodged during dental examination. Although retained incisors commonly occurred rostral to corresponding permanent incisors, a few occurred caudally. Abnormal incisor eruption presented as spiral twisting of the crowns of affected teeth. This resulted in the rostro-caudal compression of the crowns being oriented in a longitudinal rather than a transverse direction when viewed from the occlusal surfaces. This occurrence was noted in two patients with normal incisive occlusion.

Excessive wear of incisors manifested as loss of the dental star representing secondary dentine. This accompanied by root exposure and increased mobility within the alveolus, was noted in five donkeys estimated to be over 15 years old from owner history. In one donkey, wearing occurred up to the gingival margin (Figure 41) and also exhibited wear of the enamel of the labial surfaces of the incisors, as opposed to wear the occlusal surfaces. Uneven wear of the incisors resulted in uneven incisive

arcades and resultant poor occlusion. Occurrence of a sea-gull shape of the arcade during occlusion was also noted in one donkey with a broken incisor (Figure 42).

Shedding incisors presented transient dental occurrences associated with the trapping of feed material between the newly erupting teeth and the deciduous teeth being replaced. Mild gingivitis occurred and appeared as reddening of the gingival margins. Feed material was also trapped within the crypt created by the shedding incisor. Traumatic injury by the exposed roots of the shedding incisors caused trauma and ulcerations on the mucosa of the upper lip, corresponding to the point of contact with the roots. Presence of a shedding corner incisor was associated with an ulcerative lesion on the tongue in one patient due to contact with the crown of the tooth. Incisor fractures involved loss of part of the enamel or occurred as fissures or cracks on the tooth surface (Figure 42). Broken incisors were observed in 3 cases with a history of trauma to the mouth. Exposure of dentine due to loss of enamel was accompanied by dark discoloration, representing reparative secondary dentine.

Figure 40; Retained deciduous incisor with an exposed root (arrow). Ulceration on labial mucosa due to exposed root (circled).

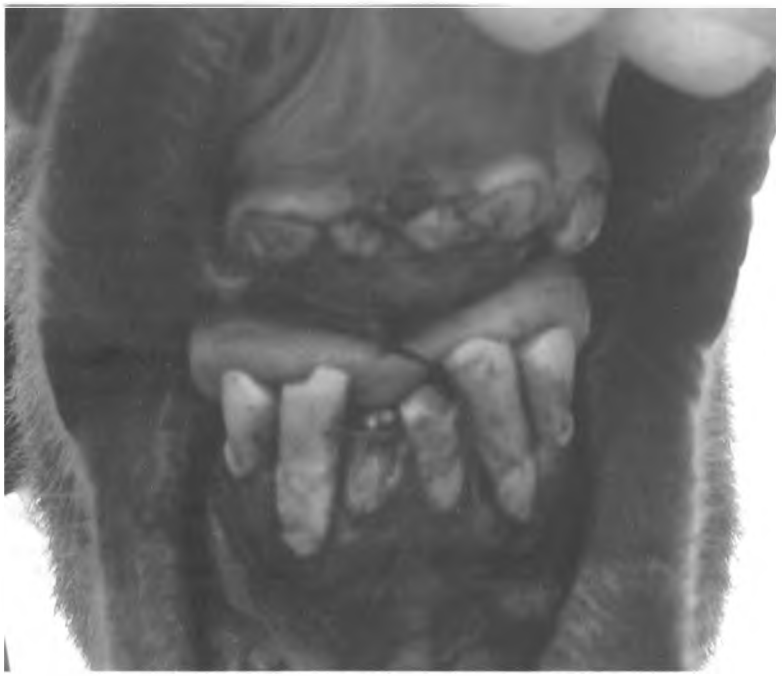


Figure 41; Excessive wear of upper incisors up to the gums.

Figure 42; 'Seagull' mouth with a broken central mandibular incisor (arrow).

4.2.1.5 SHARP ENAMEL EDGES

Sharp enamel edges were observed in 8.8% of cases. These were palpated on the dental arcade on the buccal edges of the upper cheek teeth and on the labial edges of the lower cheek teeth. Intra-oral palpation usually confirmed the occurrence as sharp, acutely angled spikes (Figure 43). The lateral excursion of the jaws was also reduced in cases with sharp enamel edges of the cheek teeth. This was judged by holding the mouth shut to achieve occlusion of the cheek teeth then moving the mandible laterally by hand. In some donkeys, this maneuver increased the space between the occluding incisors during the lateral excursion. Superficial ulcers on the buccal mucosa were visible in extreme cases. Donkeys with sharp enamel edges retained food boli in the lateral oral vestibules thus causing facial asymmetry. This was restored after removal of the boli during examination and eventual corrective rasping.

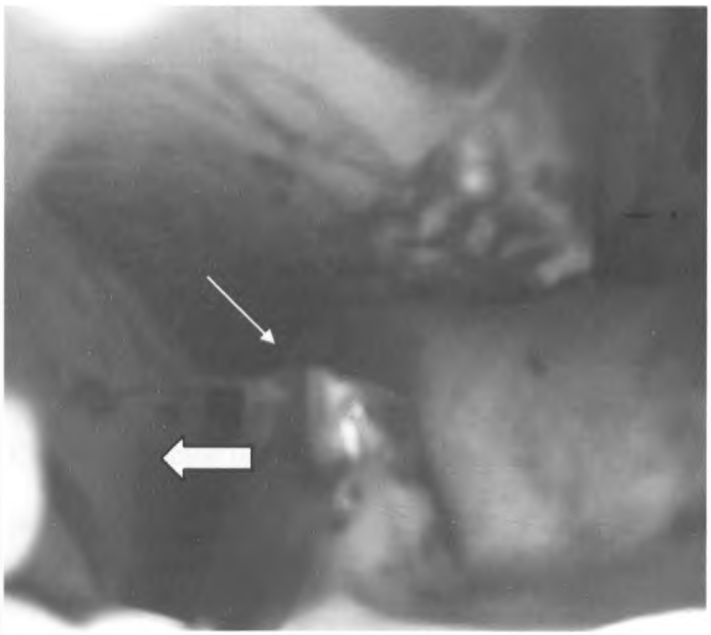


Figure 43; Sharp enamel edges on labial margins of mandibular cheek teeth. Tongue (solid arrow).

4.2.1.6 STEP MOUTH

Step mouth was observed in 7.1% of cases. It appeared as variable lengths of teeth in the cheek teeth arcades. Oral examination and palpation revealed sharply varying crown lengths between adjacent teeth. In two donkeys, the condition was associated with teeth loss and subsequent overgrowth of the opposing cheek teeth.

4.2.1.7 ROSTRAL HOOKS

Rostral hooks affected 7.1% of the donkeys examined, occurring as focal enamel overgrowths of the first upper premolar crowns. The lengths of the hooks determine the ease with which they could be rasped into conformation, with the long hooks being hardest.

4.2.1.8 LOOSE TEETH

Loosening of permanent teeth involved cheek teeth and incisors. Involved teeth, especially incisors, were freely mobile in their alveoli on digital manipulation.

4.2.1.9 DISCOLORED TEETH

A history of trauma was associated with teeth discoloration in two cases examined, but no attributable history was associated with teeth discoloration in the other cases. Changes in color of the crown surface varied in shades of brown. Traumatic injury produced a dark brown color. With gross wearing of the enamel on the labial surface, the pattern of discoloration appeared conical with the base towards the tip of the crown. Teeth discoloration was noted in 4.7% of donkeys and often involved the incisors (Figure 44).

4.2.1.10 MANDIBULAR AND MAXILLARY SWELLINGS

Swellings on the mandible (1.8%) and maxilla (0.6%) (Figure 45). These were evaluated vis a vis expected bony swellings associated with enlarged alveolar spaces of growing cheek teeth, or as indicators of existing dental conditions. In one case, there was evidence of a healed mandibular fracture without alteration of function of the corresponding dental arcade. Maxillary swelling occurred as, hard painless lump on the face below the eye.

4.2.1.11 NECROTISING STOMATITIS AND TRAUMATIC CHEILITIS

Feeding on maize stover was associated with necrotising stomatitis (Figure 46) of the gingival and buccal mucosa in three donkeys, and traumatic cheilitis in two donkeys. Linear erosions appeared on the fornix at the junction of the buccal and gingival mucosa of the upper and lower jaws. The lesions were covered with a white, sticky discharge and produced a mild degree of halitosis, erythema, swelling and resentment to touch. Traumatic cheilitis was characterized by linear erosions, erythema, swelling and white tenacious discharge on the margins of the lower lip. Necrotising stomatitis occurred in **1.76%** and cheilitis in **1.18%** of cases seen.

4.2.1.12 GINGIVAL HYPERPLASIA

Gingival hyperplasia was documented in two donkeys (1.2%). Although no inflammatory reaction was observed in the two donkeys with gingival hyperplasia, flaps of healthy gingiva persisted on the free gingival margin of the upper central and lateral incisors (Figure 40).

Figure 44; Discoloration of central upper incisors.

Figure 45; Mandibular swelling (left) and Maxillary swelling (right).

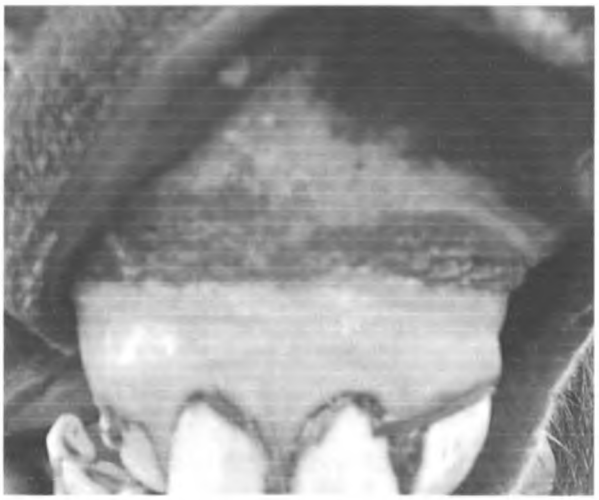


Figure 46; Necrotising stomatitis on mucosa of upper gum.

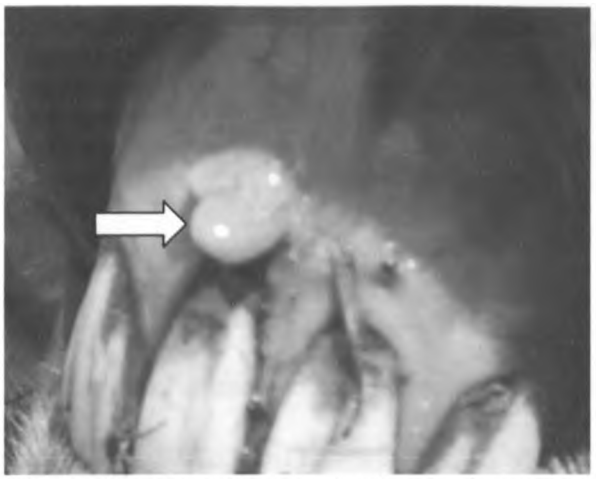


Figure 47; Flap of hyperplastic gingiva on margin of upper gum.

4.3 INTERVENTIONS FOR DENTAL CONDITIONS IN DONKEYS

These were carried out under physical restraint using manual instruments.

4.3.1 FLOATING / DENTAL RASPING

The conditions requiring dental rasping included; wavemouth, sharp enamel edges, step mouth and premolar hooks. Manual dental rasps fitted with tungsten carbide planing blades were used and the detachable blades worked well since they did not clog quickly with enamel grit. The rasps were dipped in a 1% solution of iodine during the procedure that also assisted with removal of the enamel grit. Wave mouth and step mouth required more time and more strokes to correct sufficiently as compared to sharp enamel edges and hooks. The use of manual rasps was taxing but results were satisfactory in terms of removing irregularities on dental arcades due to abnormal wear. The small size of the donkey allowed for good control over the degree of rasping due to easy access to the oral cavity.

Free lateral excursion of the jaw was restored in most of the patients rasped to remove irregularities of wear. This allowed movement of the jaw to either side without loss of contact between the incisor arcades. Even when full contact was not re-established, the distance between the incisor arcades was greatly reduced after rasping.

4.3.2 EXTRACTION

Twisting and traction extracted loose teeth. Persistent shedding incisors were most commonly extracted in this way since they had little of gingival attachment and no periodontal ligament attachment. Bleeding was insignificant in such cases and the immediate relief from irritation to the gums and lips from the shedding incisors was obvious.

Enamel caps on cheek teeth easily came off during routine floating. Otherwise, they were removed by wedging the tip of the rasp against them and then tapping the handle with the palm of the hand. The caps were then manually retrieved from the oral cavity before flushing with plain water.

4.3.3 TOPICAL ANTISEPSIS

This was done for cases with oral ulcers due to necrotising stomatitis and cheilitis due to trauma. A 1% solution of iodine was used together with a cotton gauze swab to remove necrotic debris from the surfaces of the ulcers. This was deemed fit due to the shallow nature of the ulcer. The owners were also advised not to feed dry maize stover to donkeys to avoid injury to the oral mucosa. Dilute iodine solution (1%), was dispensed for topical treatment of the ulcers by the owners at home.

CHAPTER FIVE

5.1 DISCUSSION

This study aimed to determine the prevalence, clinical features and interventions of dental conditions affecting dogs and donkeys in Kenya. Dental radiology was also performed in dogs under general anaesthesia using a conventional portable x-ray unit.

DOG STUDY

In a survey done in the United States and Australia, dental conditions ranked amongst the most common, alongside diseases of the musculoskeletal, gastrointestinal, and hepatic systems (Freeman et al., 2006). The current study documented a prevalence of dental conditions in dogs of 28.9%. It is, however, noted that most patients were referred to the clinic for other reasons and dental conditions were incidental upon purposive oral examination. Kyllar and Witter (2005) reported a higher prevalence rate of 85.3% in the Czech Republic, from cases sampled from veterinary dental practices. The type and frequency of conditions encountered in the two studies were similar and included periodontitis, dental calculi, missing teeth, and less commonly, dental caries, oral tumors and dental hypoplasia. The observation in the current study that periodontal conditions had the highest frequency compared to endodontic conditions and miscellaneous dental conditions, was consistent with a similar study in the Netherlands (de Meijer et al., 1991).

The modified Triadan dental nomenclature system (Floyd, 1991) was used for recording data on clinical and radiographic examination of dogs and donkeys. It captures the historical aspects, diet, existing home dental care and previous dental

interventions as well as the current dental status on examination, proposed action plan, radiographic findings and proposed future interventions.

Dental plaque was the most prevalent (89.7%) dental condition. Plaque is composed of bacteria within a matrix of salivary glycoproteins and extracellular polysaccharides. The presence of bacteria contributes to propagation of dental plaque, formation of calculi, gingivitis and periodontal disease. The most obvious gingival alteration associated with the presence of plaque was hyperemia of the free gingival margin and increased depth of the gingival sulcus on probing with a periodontal probe or a shepherd's crook dental explorer.

The extent of alterations in the normal anatomy of the gingiva depended on the level of inflammation and the degree of plaque and or calculi deposition. The most common sign of gingivitis in this study was change in color from a healthy pink to different levels of hyperemia. This was seen as reddening of the gum that started at the free gingival margin and extended to various distances towards or beyond the mucogingival junction. This was difficult to judge in patients that had pigmented gums. In some cases, the determination of capillary refill time was also difficult due to diffuse hyperemia.

Halitosis is the most common complaint associated with dental conditions, and was observed in periodontal disease, necrotising gingivitis, glossitis and extensive oral neoplasia. Although halitosis by itself is not a dental condition, its direct relationship with most dental conditions lends its prime importance in veterinary dentistry (Bojrab & Tholen, 1990).

Calculi deposits were thicker on the labial and buccal surfaces of the affected teeth and much less on the lingual and palatinal surfaces. In this study, the most commonly affected tooth was the upper carnassial. This is consistent to findings by Kyllar and Witter (2005). The parotid salivary gland duct opens adjacent to the upper carnassial thus depositing saliva directly onto its surface. Saliva carries minerals that get incorporated into plaque forming calculi affecting mostly the upper carnassial.

Dental calculi on its own does not cause gingivitis, but plaque embedded within its crevices and uneven surface is hard to dislodge and will cause gingivitis. The importance of dental calculi in dental health is associated with dental plaque and its resultant effects. Another important aspect of dental calculi is aesthetics with more pet owners being aware and paying more attention to the presence of unsightly calculi deposits on their pet's teeth.

An important observation in the study was the high prevalence of moderate to severe periodontitis with teeth loss. Loosening of teeth within their sockets was a clinical indication of involvement of the periodontal ligament and alveolar periosteitis with bone loss in severe cases of periodontal disease.

The periodontal pockets observed in the study as deepening of the gingival sulcus were attributed to loss of epithelial attachment to the tooth surface. Inflammation associated with accumulation of subgingival plaque or calculus is the inciting factor. Accumulation of food, inflammatory exudate and debris further deepens this space. Bacterial toxins with inflammation of the gingiva also deepen the sulcular crevice. Periodontal probing was useful in judging the extent of the pockets and hence

periodontitis. The extent of the breakdown of the periodontium was indicated by mobile teeth within their sockets, as determined by applying digital pressure on the crowns. Only five patients out of 68 dogs had missing teeth. In four patients loss of premolars and incisors was attributed to periodontal disease, while in one lack of eruption (agenesis) caused missing mandibular premolars on the right jaw. This was consistent with the findings of Kyllar and Witter (2005) who recorded the teeth commonly affected as premolars, incisors and molars in that order. Teeth loss has been reported to be due to either periodontal disease (Kyllar & Witter, 2005) or trauma (Bittegeko et al., 1995). Missing teeth and mobility were used as indicators of advanced periodontitis and a warrant for diagnostic dental radiology.

Although endodontics involves diagnosis and treatment of conditions within the tooth, this study was confined to the diagnosis and characterization. Endodontic therapy was beyond the scope of this study. Examination for endodontic conditions revealed fractured teeth, dental caries, pulp exposure due to fractures or attrition and dental fistulas. In the cases seen with endodontic involvement, regional lymphadenopathy and facial swelling presenting as facial asymmetry were evaluated by palpation, and radiology carried out to assess suspected teeth. Exposure of the pulp due to endodontic injury showed discoloration due to staining of the dentine with blood pigments or presence of reparative dentine. Fractures were most common in canine teeth and least frequent in incisors. Fracturing is associated with fights, accidents or bones in the patient's diet. Radiology was used to assess the involvement of subgingival structures.

The dental caries observed in 19.1% of patients were diagnosed during routine scaling. The low frequency of dental caries in dogs is probably due to the fact that the

non-acidophillic bacterial flora in the canine mouth may not predispose to dental caries. The anatomical conformation of the crown and the thicker layer of enamel could be another reason (Kyllar & Witter, 2005). The incidence according to Ettinger (1995) is also low due to the canine diet that is usually low in fermentable carbohydrates. The crowns, designed for shearing in dogs are such that they are self-cleaning. Additionally, the fissures of the crown are exposed to an abrasive diet and the crowns have no true pits in their surface relief (as in other species) that would hold food debris and bacteria. This is an exception in the maxillary molars, a common site for caries. The spaces between teeth in the dog do not trap food as seen in other species with higher caries indices. The pH of the dog saliva is alkaline which tends to neutralize oral acids further contributing to the low incidence.

Dental fistulas were observed in only 2.9% of cases. Commonly, fistulas form to drain periapical abscesses or alveolar bone infections. In one case seen, a fistula formed through alveoli left vacant after shedding of a tooth due to squamous cell carcinoma with infection. In another case, a sinus tract developed from an infected carnassial draining on the face.

In clinical examination, the draining lymph nodes of the head were examined and changes were noted in the consistency, location and size of the submandibular lymph nodes and tonsils. The mandibular lymph nodes were easily palpable clinically and are good indicators of pathological changes in their drainage area, such as neoplasia and inflammatory processes. In three cases the submandibular lymph nodes were enlarged bilaterally, associated with glossitis. In three other cases, the tonsils were

inflamed and visible outside their crypts, appearing red and swollen. These patients also had glossitis and the tonsilitis was attributed to the local spread of infection.

Deviation in the normal number of teeth or their placement is a common occurrence in dogs, especially in the brachycephalic breeds and much less in the dolichocephalic breeds. In two out of the five cases encountered, the condition was congenital in Spitz and Pomeranian crosses, involving the incisors and canines. In the last case encountered, the right mandibular canine was displaced through an angle of 90° outwards due to malunion of a mandibular ramus fracture, after being hit by a vehicle. Trauma to the mandible may cause partial or total avulsion of a tooth from the jaw. Partial avulsion causes distortion as the tooth heals by the remaining periodontal ligament or by ankylosis of the alveolar bone to the cementum (Ettinger, 1983).

Extraction is indicated for malaligned teeth that cause trauma on soft tissues. Grinding offending tips back to shape can also be done, saving the tooth. One dog had multiple supernumerary teeth. This was due to a complex odontoma around the mandibular canine. Bizarre odontomas with large numbers of formed or partly formed teeth are uncommon and may cause an obvious distortion of the jaw (Ettinger, 1983). Although the jaw was not distorted, the condition was aesthetically unappealing, therefore extraction of all the multiple teeth was done and cosmesis achieved.

The mandibular brachygnathism in three cases (Spitz, Pomeranian and a German shepherd dog) led to malocclusion, with teeth causing trauma on soft tissues. Drooling was also seen in cases with this condition.

Retention of deciduous teeth leads to malalignment and malocclusion of erupting permanent teeth. In two cases, retained deciduous canines resulted in the permanent canines erupting out of line. Lack of timely shedding may be due to lack of hard foods, such as biscuits and bones, in a young dog's diet. Routine extraction of the retained deciduous canines was done. Digital pressure applied on the erupting permanent canines four times a day for as long as the pet could tolerate, was indicated to correct malalignment in one patient.

Tumors of the maxilla or mandible require partial maxillectomy or mandibulectomy in the absence of metastasis to other tissues, or if local damage due to infiltration of the tumor is minimal. Two cases with oral tumors were, however, euthanised. One dog had an extensive squamous cell carcinoma of the gum, infiltrating into the maxilla. Spontaneous squamous cell carcinomas of oral origin are common in dogs and cats (Bradley, 1984, Gardner, 1996). Another had an odontogenic tumor with metastasis to the lungs, kidneys, liver and spleen.

Glossitis is associated with trauma to the tongue during fights. Dogs will bite their own tongues in furious fights, with subsequent infection. Partial glossectomy is indicated when glossitis is caused by foreign bodies such as rubber bands around the tongue. In this study, infections of the tongue were managed using systemic antibiosis and topical antisepsis in routine dental prophylactic procedures. The response to treatment was satisfactory. Tonsilitis, with hyperemic tonsils visible outside the tonsilar crypts on oral examination, was a common associated feature occurring with glossitis.

Dental intervention procedures carried out in the dog were successful. Gingivectomy restored gingival margins and obliterated gingival pockets. This was done in conjunction with dental prophylactic procedures, such as scaling, in management of periodontal disease.

Extractions were carried out for retained deciduous teeth and for permanent teeth devitalized beyond redemption by periodontitis. Caution was observed to avoid fracturing alveolar bone, damage to adjacent teeth or erupting permanent teeth. Erupting permanent teeth were preserved when extracting adjacent retained deciduous teeth by careful luxation and avoiding use of the erupting tooth for leverage.

Systemic antibiotic treatment was administered to patients under admission or dispensed for medication at home with satisfactory client compliance and positive therapeutic outcomes.

Adaptation of conventional x-ray equipment was successful in obtaining dental radiographs. The value of periodontal radiology is immense compared to panoramic or whole head radiology. The technique adapted made use of both panoramic and periodontal radiology. The latter was done using specialised dental film for intra-oral radiology. The interpretation of radiographs depended on good knowledge of the normal radiographic anatomy and use of correct techniques (Eisner, 1990, Eisner, 1998, Pepelassi & Diamanti-Kipioti, 1997). Subtle changes in the periodontal structures and the alveolar were most critical in the reading and interpretation of the radiographs. Changes were noted in the enamel, dentine, pulp cavities and supporting alveoli with the periodontal ligament space, lining of cortical bone –the laminar dura

and trabecular bone surrounding the alveoli. The most obvious changes included the loss of architecture of the named structures, a finding consistent with those of other authors (Gorrel, 1998, Bellows, 1993, Emily, 1998, Luskin & Kressin, 2001).

DONKEY STUDY

A significant finding of the study was a prevalence of 12.3% for dental conditions in donkeys. This is the first prevalence study of dental conditions in donkeys in Kenya. Although studies in the UK have associated dental conditions as a risk factor for impaction colic in donkeys, the overall prevalence of dental conditions has not been stated (Cox et al., 2007).

The high prevalence of dental conditions (70%) in donkeys observed at the KSPCA clinic should be interpreted with caution due to the small sample size from a biased population of donkeys with other medical and surgical conditions. Nevertheless, the moderately high prevalence of dental conditions observed from Mweiga, Limuru and Kiambu, indicates their significance requiring intervention. In addressing this problem, donkey welfare clinics and extension education programs are being offered by veterinary professionals in the private and public sectors.

The most prevalent dental condition was wavemouth (18.8%). This condition and others comprising disorders due to abnormal wear (excessive wear, sharp enamel edges and hooks) were associated with erratic diet habits. This could be attributed to the way donkeys were kept in the various regions visited for the study. Neglect, negative attitudes towards the donkey, and how they are used may have influenced their dietary habits and thus wear patterns. For example, in Bomet, only 3 (0.5%) of

the 603 donkeys examined, had dental conditions mainly abnormal wear patterns such as wavemouth. In this region donkeys are kept in natural conditions, being used to fetch water, carry farm produce for the market or charcoal, but left for most of the day to graze freely on wild vegetation. This probably contributed to the low frequency of dental conditions in these donkeys as compared to donkeys from other regions in the study.

The oral cavity was examined with donkeys under physical restraint. This dispelled the perception by the owners that donkeys bite on the slightest provocation. An important aspect of the donkey study was the detailed description of the type and frequency of dental conditions encountered in the field, previously unreported in literature. Conditions stemming from uneven wear were some of the commonest. Uneven wear can be triggered by loss of teeth and enamel caps over the cheek teeth. Enamel caps interfere with normal mastication. This can be transitional if the caps fall off by themselves, but if they do not fall off or are not extracted, they induce and sustain abnormal wear. Enamel caps were, however, easily removed during rasping.

Dental calculi commonly affected the canine teeth and may be attributed to the lack of functional occlusal that breaks off calculi deposits during mastication. In 8.24% of cases, calculi occurred with gingival margin hyperemia and swelling, indicating gingivitis due to bacterial plaque within the deposits.

An interesting finding was the fact that several donkeys over 20 years of age were in relatively good body condition despite severe dental disease. Incisor conditions were encountered with varying effects on the prehension and mastication. Donkeys with

excessive wear of the incisors were still capable of prehension. In one patient, the occurrence of a shedding corner incisor was associated with an ulcerative lesion on the lip, due to contact with an exposed root. This interfered with prehension due to pain when the labial mucosa contacted the exposed root. Donkeys use the lips to pick food before mastication, and injury to the lip would, therefore, affect nutrition. This, though, would be transient, lasting only until the tooth is shed, when irritation ceases and normal prehension resumes.

Crown fractures with pulp or dentine exposures lead to increased sensitivity and reluctance to feed or drink water. Sensitivity resolves over time as the defects are sealed by reparative dentine that is usually dark brown. Incisor conditions cannot be overlooked since the incisors are involved in the initial stages of mastication, especially when donkeys feed on natural vegetation.

The sharp enamel edges on cheek teeth hinder effective mastication by inhibiting lateral excursions of the jaws required for grinding manifested large particle sizes of undigested forage in the feces. Manually simulating the lateral grind led to the increase in the space between the occluding incisors during the lateral excursion. This was due to the vertical displacement of the jaw movement caused by the vertical outcrops of the sharp enamel edges. This proved a consistent diagnostic sign. Sharp enamel edges and rostral hooks also caused trauma and superficial ulcers on the buccal and lingual mucosa and were the reason for careful chewing. Affected donkeys retained food boli in the lateral oral vestibules, causing facial asymmetry. The occasional dropping of the retained bolus from the mouth (quidding) is a clinical sign of abnormal wear in cheek teeth.

Loosening of teeth within the alveoli could be due to trauma to the mandible or maxilla. In addition, advanced periodontal disease leads to loss of periodontal ligament attachments, enlargement of the alveoli due to accumulation of serum or pus with bone loss thus loosening of teeth (Emily & Penman, 1994). Senescence with natural wear was the cause for loose teeth seen in this study.

In this study, discoloration of teeth was associated with presence of reparative dentine secondary to trauma or abnormal wear of incisors. The imbibition of hemoglobin into the dentine following trauma could also cause discoloration.

The swellings observed on the face and jaws were attributed to changes in the dental alveoli in increased physiological activity during eruption of permanent cheek teeth, or from trauma. Although palpation or percussion may obtain tentative diagnosis, definitive diagnosis requires radiology. Intra-oral examination would reveal loose teeth or discharging dental fistulae in cases of tooth root infections. Field cases seen showed hard, painless bony swellings without involvement of the teeth on intra-oral examination. They did not interfere with mastication so did not justify radiology.

Physical injury to the oral mucosa due to erratic feeding habits leads to secondary infection of the numerous lacerations with inflammation. Affected patients are reluctant to feed and resent handling. This represents neglect by owners who use the donkeys to transport quality forage for their dairy animals but, paradoxically, feed low quality forage to the same donkeys. The lesions observed as necrotising stomatitis were due to feeding donkeys on dry maize stover.

Intervention procedures were done with the patients restrained physically with a hand twitch grasping the upper lip. Cooperative patients were gently coaxed and the owner cradled the head by passing one hand under the lower jaw, while the operator opened the oral cavity for dental work. Grasping the tongue and exteriorizing it prevented the patient from closing the mouth. The short stature of the donkey makes manual restraint comfortable, providing easy access to the oral cavity by the operator.

Dental rasping was the most commonly done procedure since most of the conditions involved abnormal wearing. Manual rasps were used with interchangeable tungsten carbide inserts, which were efficient as they did not clog easily with enamel grit and feed material. In field situations, this allowed many patients to be attended in a short time. It also minimized the time taken cleaning and unclogging the grinding surface of the rasps during rasping, or between patients. The use of dilute iodine solution (<5%) to rinse the float and to flush the oral cavity during rasping achieved topical antisepsis and saved time, as opposed to using plain water then using an antiseptic after rasping is completed. The use of a narrow mouth plastic jerry can to hold the rasps and the diluted iodine solution minimized the noise level, since the patients were not sedated, as opposed to using a metallic bucket. The portability of this set-up also lends itself well to field situations where all the work is done without the use of restraining stocks or stalls.

Dental conditions in donkeys corrected by floating included; wavemouth, sharp enamel edges, step mouth and premolar hooks. These are best corrected using power tools that are not always available in practice (Whitehead et al., 1991). Nevertheless, some focal overgrowths were tackled satisfactorily with manual rasps. Manual

rasping is also more precise, though it takes more time and is tiring, as opposed to using powered tools. The outcome was good in cases of sharp enamel edges and premolar hooks, achieving complete removal of the focal overgrowths. In cases of wavemouth and stepped mouth, more time was taken and extreme abnormalities were not completely obliterated, especially where the wear was close to the gums. In these cases, excessive rasping was contraindicated to avoid 'smooth mouth' which would retard mastication much more than the pre-existing wavemouth or stepped mouth.

Extraction was easily performed on donkeys under physical restraint and was an effective remedy for loose teeth, shedding incisors, persistent deciduous incisors and enamel caps. This could be attributed to the fact that they were not firmly attached or they were being shed anyway.

5.2 CONCLUSIONS AND RECOMMENDATIONS

5.2.1 CONCLUSIONS

The study has documented the prevalence, clinical features and interventions for dental conditions in dogs and donkeys. The data is useful in highlighting the nature and frequency of dental conditions encountered in these species. The clinical significance of the dental conditions in the two species has been highlighted in their diagnosis and interventional procedures successfully performed. The prevalence of dental conditions in the two species emphasizes the importance of including dental evaluation in clinical examination of these animals.

Conventional x-ray equipment can be successfully used for dental radiology as an invaluable tool for assessment of endodontic conditions.

The application of the findings of this study by veterinarians, animal scientists and owners should enhance the heath and welfare status of these animals. In addition, the information will be useful for training undergraduate and postgraduate students.

Objective scientific data from this study forms a basis for further research in veterinary dentistry of dogs and donkeys in Kenya with the ultimate goal of improving the practice of veterinary dentistry.

5.2.2 RECOMMENDATIONS

Dental radiology using appropriate dental radiology techniques for the dog should be incorporated in routine dental procedures.

The Modified Triadan dental recording system is recommended for clinical dental practice in companion animals. It is precise and incorporates dental charts for indication of dental findings.

More investment should be made in training for veterinary dentistry including provision of dental equipment for training institutions. This would increase awareness and interest in the field.

Future research would be recommended in advanced diagnostic imaging modalities such as Computed Tomography as well as endodontic therapy, orthodontics, laser technology, cosmetic dentistry and comparative dental studies.

Considering the documented prevalence of dental conditions in dogs and donkeys, it is recommended that veterinary professionals and animal owners pay more attention to the dental health of these animals.

CHAPTER SIX

6.0 REFERENCE

Baker G. J. (1998). Dental Physical Examination. The Veterinary Clinics of North America Equine Practice **14** (2): 247-257.

Bellows J. (1993). Radiographic Signs and Diagnosis of Dental Disease, Seminars in Veterinary Medicine and Surgery (Small Animal) **8** (3): 138-145.

Bittegeko S.B., Arnbjerg J., Nkya R. and Terik A. (1995). Multiple Dental Developmental Abnormalities following Canine Distemper Infection. Journal of the American Animal Hospital Association **31**: 42-45.

Blench, R. (2004). The History and Spread of Donkeys in Africa, Fielding D and Starkey P., (2004) A Resource Book of the Animal Traction Network for Eastern and Southern Africa (ATNESA). Technical Centre for Agricultural and Rural Co-operation (CTA), Wageningen, Netherlands.

Bojrab J.M., Ellison G.W. and Slocum B. (1998). Current Techniques in Small Animal Surgery, Williams & Wilkins, 351 West Camden Street, Baltimore, Maryland 21201-2436,USA. Pg 639-642.

Bojrab J. and Tholen M. (1990). Small Animal Oral Medicine and Surgery, Lea & Febiger. Pg 1-25.

Boyd J.S. Paterson C. and May A.H. (2001). Colour Atlas of Clinical Anatomy of the Dog and Cat, 2nd Ed. Mosby International Ltd.Pg 29,44-45.

Bradley R.L., MacEwen E.G. and Loar A.S. (1984). Mandibular Resection for Removal of Oral Tumours in 30 Dogs and 6 Cats, Journal of the American Veterinary Medicine Association **184** (4): 460-463.

Cox R., Proudman C.J., Trawford A.F., Burden F. and Pinchbeck G.L. (2007). Epidemiology of Impaction Colic in Donkeys in the UK. BMC Veterinary Research **3**:1-11.

Crane M.M. (1997). In; Svendsen E.D., Professional Handbook of the Donkey. 3rd London, Whittet Books Ltd. 19-35.

de Meijer L.M., Truin G.J., van Foreest A.W. and Plasschaert A.J. (1991). Veterinary Dentistry in Dogs and Cats. Results of a Post-inquiry in the Netherlands. Nederlands Tijdschrift voor Tandheelkunde **98** (11): 455-456.

Dyce K.M., Sack W.O. and Wensing C.J.G. (1987). Textbook of Veterinary Anatomy. WB Saunders, the Curtis Center, Independence Square West, Philadelphia, Pennsylvania 191906.

Eisner E.R. (1990). Problems Associated with Veterinary Dental Radiography. Problems in Veterinary Medicine **2** (1) 46-84.

Eisner E.R. (1994). Professional and Home Dental Care of the adult Dog and Cat. www.eukanuba-scienceonline.com/radhm_nov2003/pdf/

Eisner E.R. (1998). Oral –Dental Radiographic Examination Technique. The Veterinary Clinics of North America Small Animal Practice **28** (5) 1063-1087.

Emily P. (1998). Endodontic Diagnosis in Dogs. The Veterinary Clinics of North America Small Animal Practice **28** (5) 1189-1202.

Emily P., Penman S. (1994). Handbook of Small Animal Dentistry 2nd Ed. 1994. Pergamon Press. 1-112.

Ettinger S.J. and Feldman E.C. (1995). Textbook of Veterinary Internal Medicine, Diseases of the Dog and Cat. WB Saunders Company. 1084-1121.

Evans H.E. (1993). Miller's Anatomy of the Dog, 3rd Ed., WB Saunders, the Curtis Center, Independence Square West, Philadelphia, Pennsylvania 191906.

FAO (1997). FAO Statistical Database Website. Food and Agriculture Organisation, Rome Italy.

www.apps.fao.org/lim500/nph-wrap.pl?Production.Livestock.Stocks&Domain=SUA

Fernando P. and Starkey P. (2004) Donkeys and Development; Socio-economic Aspects of Donkey Use in Africa, Donkeys, People and Development, Fielding D and Starkey P., (2004) A Resource Book of the Animal Traction Network for Eastern and Southern Africa (ATNESA). Technical Centre for Agricultural and Rural Co-operation (CTA), Wageningen, Netherlands.

Floyd M.R. (1991). The Modified Triadan System; Nomenclature for Veterinary Dentistry. Journal of Veterinary Dentistry **8** (4); 18-19.

Freeman L.M., Abood S.K., Fascetti A.J., Fleeman L.M., Michel K.E., Laflamme D.P., Bauer C., Kemp B.L., van Doren J.R. and Willoughby K.N. (2006). Disease Prevalence among Dogs and Cats in the United States and Australia and proportions of Dogs and Cats that Receive Therapeutic Diets and Dietary Supplements. Journal of American Veterinary Medicine Association **229** (4): 431-434.

Gardner D.G. (1996). Spontaneous Squamous Cell Carcinomas of Oral Origin in Domestic Animals; A review and Consideration of their Relevance to Human Research. Journal of Oral Diseases **2** (2): 148-154.

Gorrel C. (1998). Radiographic Evaluation. The Veterinary Clinics of North America, Small Animal Practice **28** (5): 1089-1110.

Harvey C.E., O'Brien J.A., Rossman L.E., Stoller N.H. (1983). In; Etttinger S.J., Textbook of Veterinary Internal Medicine, Diseases of the Dog and Cat. WB Saunders Company. 1126-1187.

Hennet P. R., Delille B. and Davot J. L. (1998). Oral Malodor Measurements on Tooth Surface of Dogs with Gingivitis. American Journal of Veterinary Research **59**: 255-257.

Kaumbutho P., Waithanji, E. and Karimi, A. (2004). Donkey Power in Context of Smallholder Mechanization and Agribusiness in Kenya. In; A Resource Book of the Animal Traction Network for Eastern and Southern Africa (ATNESA). Fielding D and Starkey P. (Eds.). Technical Centre for Agricultural and Rural Co-operation (CTA), Wageningen, Netherlands.

Kern D. A., Smith M. M., Stevenson S., Moon M. L., Saunders G. K., Irby M. H. and Dyer K. R. (1995). Evaluation of Three Fixation Techniques for Repair of Mandibular Fractures in Dogs, Journal of the American Veterinary Medicine Association **206** (12).

Kyllar M. and Witter K. (2005). Prevalence of Dental Disorders in Pet Dogs, Journal of Veterinary Medicine-Czech **50** (11): 496-505.

Lage A., Lausen N., Tracy R., Allred E. (1990). Effect of Chewing Rawhide and Cereal Biscuit on Removal of Dental Calculus in Dogs. Journal of the American Veterinary Medicine Association **197** (2).

Lowder M.Q. and Mueller P.O. (1998). Dental Embryology, Anatomy, Development and Aging. Veterinary Clinics of North America. Equine Practice **14** (2): 227-245.

Luskin I.R. and Kressin D.J. (2001). Endodontic Decisions based on Radiographic appearance. Clinical Techniques in Small Animal Practice **16** (3): 173-181.

Muylle S., Simoens P., Lauwers H. and Van Loon G. (1999). Age Determination in mini-Shetland Ponies and Donkeys, *Zentralbl Veterinarmed* A **46** (7): 421-429.

Patrick T.C., Ian G. M., Alfred M. M., and James N. M. (1991). Equine Medicine and Surgery, 4th Ed. Vol. 1 American Veterinary Publications Inc. pg 550-570.

Pepelassi E.A. and Diamant-Kipioti A. (1997). Selection of the Most Accurate Method of Conventional Radiography for the Assessment of Periodontal Osseous Destruction. Journal of Clinical Periodontology **24** (8): 557-567.

Plumb D.C. (1999). Veterinary Drug Handbook, Pharma Vet Publishing, White Bear Lake, Minnesota.

Ralston S. L., Foster D. L., Divers T. and Hintz H. F. (2001). Effects of Dental Correction on Feed Digestibility in Horses, Equine Veterinary Journal **33** (4): 390-393.

Soulsby E. J. L. (1997). In; The Professional Handbook of the Donkey by Elizabeth D Svendsen., Whittet Books Limited, 18 Anley Road, London.

Starkey P. and Starkey M. (2004). Regional and World Trends in Donkey Populations. In; A Resource Book of the Animal Traction Network for Eastern and Southern Africa (ATNESA). Fielding D and Starkey P. (Eds.) (2004).

Technical Centre for Agricultural and Rural Co-operation (CTA), Wageningen, Netherlands.

Svendsen E. D. (1986). The Professional Handbook of the Donkey, Sovereign Printing Group, England 9-370.

Thiemann A. K. and Bell N. J. (2001). The Peculiarities of Donkey Respiratory Disease; Equine Respiratory Diseases, Lekeux P International Veterinary Information Service, Ithaca NY (www.ivis.org)

Tholen M. and Hoyt R. F. (1990). Small Animal Oral Medicine and Surgery, Lea & Febiger. Pg 25-56.

Thrall D. E. (2002). Textbook of Veterinary Diagnostic Radiology, 4th Ed. W B Saunders. 57-84.

Tsugawa A. J. and Verstraete F.J. (2000). How to Obtain and Interpret Periodontal Radiographs in Dogs, Clinical Techniques in Small Animal Practice **15** (4): 204-210.

Tutt C. (2003). Extraction of Persistent Deciduous Teeth, UK Veterinarian **8** (1).

Vollmerhaus B., Roos H. and Knospe C. (2002). The Origin and Function of the Enamel Cap, Infundibulum Dentis on the Incisors of the Horse. Journal of Anatomy Histology and Embryology **31** (1): 53-59.

Whitehead G., French J. and Ikin P. (1991). Welfare and Veterinary care of Donkeys, In Practice pg; 67-68.

APPENDIX 1

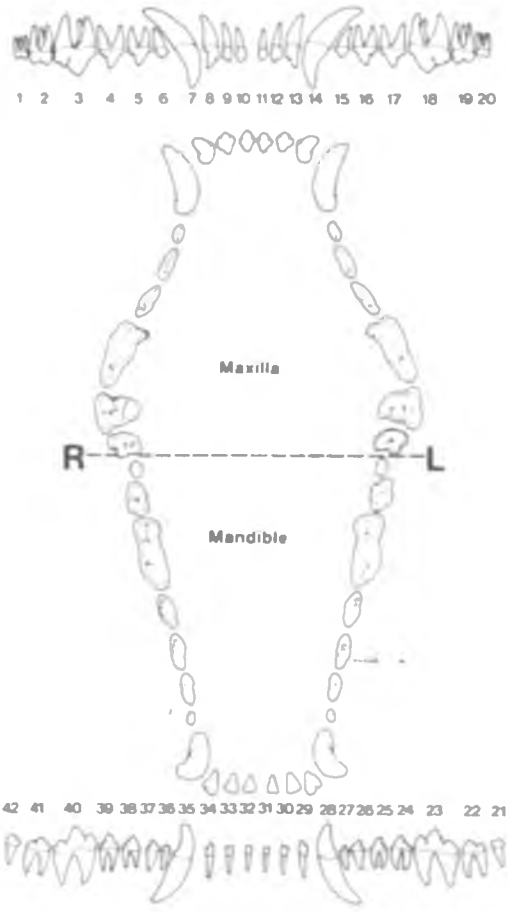
CANINE DENTAL RECORD

CANINE DENTAL RECORD

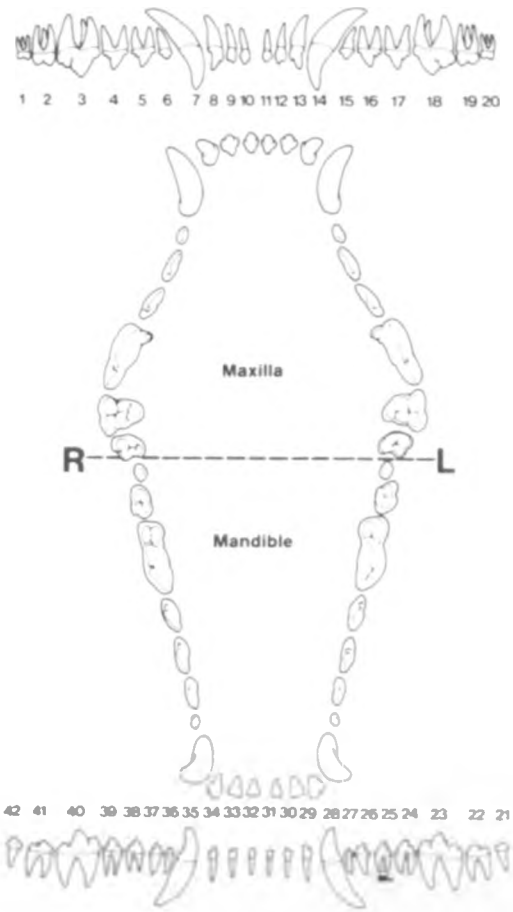
Patient _____ Owner _____
Breed _____ Phone No _____
Age/Sex _____ Date initiated _____
Chief complaint _____

Past dental history _____

Existing home dental care Brushing Oral Rinse Medication
Diet Oral habits _____



PRE-TREATMENT PATHOLOGY



GRAPHIC TREATMENT PLAN &
POST TREATMENT DENTITION

Clinical Examination

General Assessment

mucosal color and contours

trauma

caries

salivary flow dry normal excessive

lymphadenopathy

tonsils pharynx

extraoral facial structures

fistula

Periodontal Evaluation

dental plaque	mild	moderate	severe	supragingival subgingival
dental calculus	mild	moderate	severe	supragingival subgingival
gingivitis	mild	moderate	severe	generalized localized
periodontitis	mild	moderate	severe	generalized localized

halitosis

periodontal pockets

gingival recession root exposure

mobile teeth

periodontal abcess

Endodontic Evaluation

fractured teeth

carious teeth

pulp exposures

dental fistula

radiographic evidence of periapical abcess

RADIOGRAPHIC EXAM

TREATMENT PLAN

Type of Treatment

Oral Surgery — Treatment Sequence

extractions

soft tissue

jaw fracture

Periodontal Treatment — Treatment Sequence

dental prophylaxis

polishing

topical fluoride

subgingival curettage root planing

gingivectomy

home care brushing oral rinses diet

follow up

Endodontic Treatment — Treatment Sequence

single root canal filling

multiple root canal filling

apicoectomy retrograde filling

Dental Restorations — Treatment Sequence

amalgam

composite resin

Orthodontic Treatment

TREATMENT

Date	Procedure

APPENDIX 2

EQUINE DENTAL RECORD

DENTAL EXAMINATION RECORD

DATE | OWNER

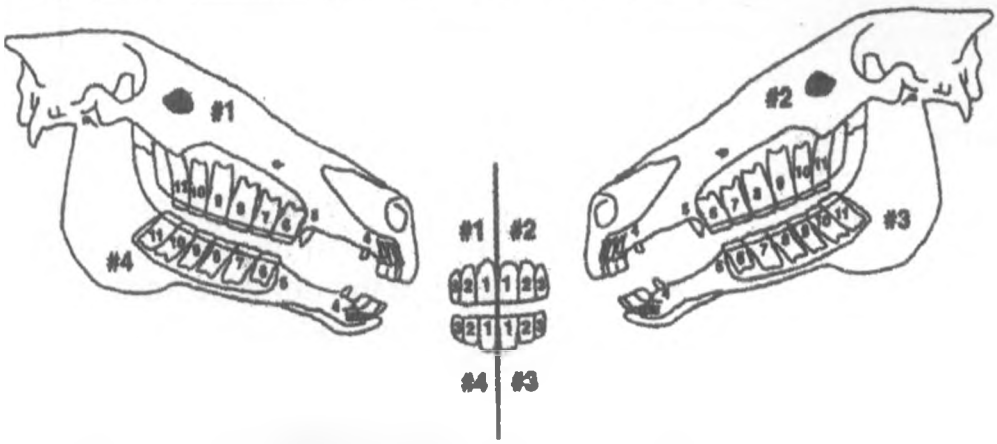
ADDRESS

SEX

Hair Coat: Condition Score: Feces: ☐Fine ☐Med ☐Course

D. Age _____ Lateral Jaw excursion: Palpation:

History: _____ Soft Tissue _____



TEETH	PROBLEM	PLAN
Incisors		
Canines		
Wolf		
#1 Arcade		
#2 Arcade		
#3 Arcade		
#4 Arcade		
Other		

RE-EXAM NEEDED