"The Distribution, Prevalence and Some Factors Associated with Periodontal Disease in Dogs and Cats"

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INTRODUCTION

Periodontal disease, (P.D.), a chronic apparently progressive inflammatory condition of the gingivae and other tissues surrounding teeth is seen in many species of animals and has been reviewed extensively by Page & Schroeder (1982). These authors referred to the disease in the dog but not in cats.

In man, there is some controversy as to whether gingivitis and periodontitis are evidence of a single disease or whether they occur independently. Page & Schroeder (1982) stated that in the dog periodontitis began on the basis of pre-existing gingivitis, and increased in prevalence and severity with age. There is no published evidence regarding the situation in cats, but it is generally assumed that it is similar to the dog.

The aetiology of periodontal disease in man and the domestic species is controversial also; in man evidence supports a bacterial origin (Van Pallenstein Helderman, 1981) leading to and probably exacerbated by hypersensitive and immunological phenomena (McPhee, 1972). The bacteria associated with gingivitis are those found in supra- and sub-gingival dental plaque which in man, and presumably in the dog and cat, accumulates due to inadequate oral hygiene. Page & Schroeder (1982) regarded periodontitis in the dog as a bacterial disease.

In the dog, veterinarians and others, have colloquially and anecdotally implicated variously, diet, the presence of dental calculus and the anatomy of skull and jaws in the development of periodontal disease. Similar observations

were also made for the cat. Mellanby (1930) purported to demonstrate that dietary deficiences, particularly vitamins A and D,in pups led to periodontal disease in later life. Subsequent authorities, by omission, have not seemed to consider either the nutritional or other biochemical aspects of diet as contributory factors in periodontal disease (Edney, 1982). The more recent research in man (Van Pallenstein Helderman, 1981) and in the dog (Page & Schroeder, 1982) implicating bacterial influences is more convincing.

None-the-less, diet consistency may be important in the progress of periodontal disease in the dog. This has been postulated by several authors including Gray (1923, and 1926); Wright (1939); Colyer (1947); Fiennes & Fiennes, (1968).

Colyer (1947) described the occurrence of periodontal disease in a variety of animals including dogs and domestic cats and noticed that 'in animals living under natural conditions, the disease is rare, but is common ..... in captive and the domestic animal'. He pointed out that the associated rarification of bone is generally more marked in the maxillae than the mandibles. Colyer (1947) stated farther that dogs and cats which lead a freer life and obtain a diet more nearly approaching their natural food were practically free from P.D., concluding that an alteration in the physical or chemical character of the diet must induce periodontal disease. Brown & Park (1968) showed that the inclusion of raw ox-tail in the diet of colonies of Beagles reduced the accumulation of dental calculus and presumably by inference the prevalence of periodontal disease.

Research into periodontal disease in the dog has been undertaken principally in colonies of Beagles, but no scientific data has been reported for similar studies in domestic dogs nor cats. Bell (1965) and Borthwick (unpublished) showed the prevalence of periodontal disease in dogs in proportion to other dental and gingival pathology to be high, approximately 70 per cent and similarly in cats (Borthwick unpublished). The previous studies by the latter indicated that the prevalence of clinical dental conditions in the dog was 2.8 per cent in the population at risk and 1.5 per cent in cats; while dental treatment accounted for 13 per cent of all surgical therapy in dogs and six per cent in cats in the Department of Veterinary Surgery, R.(D).S.V.S., Edinburgh. There also appeared to be a wide range in prevalence and severity of periodontal disease between the breeds of dogs examined.

Periodontal disease is known to be a major cause of tooth loss in man (Prevent 1: 1972) and in the dog (Bell, 1965; Borthwick, unpublished; Brown & Park 1969; Gray 1923, 1926; Page & Schroeder 1982 and Wright 1939) and in the cat (Borthwick, unpublished). Great concern has been expressed regarding the general lack of endeavour to prevent P.D. in man and world wide international efforts have been encouraged in research and prophylaxis (W.H.O. Technical Report, 1978).

This present study was undertaken to establish the periodontal status of dogs kept as companion, sporting or working animals and in household cats, to promote a better understanding of periodontal disease with a view to developing programmes of prophylaxis.

MATERIALS & METHODS

The population for study was pure bred canine and all feline patients attending the Department of Veterinary Surgery, Royal (Dick) School of Veterinary Studies, University of Edinburgh over a period of two years. The sub-populations of the animals examined were those over six months old with complete permanent dentition which had general anaesthesia for therapy or investigation. Dogs and cats admitted to the survey were those which were available when the author was available to examine them, thus no special methods of selection were applied. Patients which had dental therapy in the previous 12 months were excluded.

Details of the breed; age; sex; weight; diet; history of previous periodontal treatment and whether they were to be treated for periodontal disease or for other diseases, were recorded.

Several elaborate scoring protocols for gauging periodontal status, dental plaque and dental calculus levels have been used in man; however as the examination of the animals in this study was intrusive simpler but adequate systems were employed. The method described by Ramfjord (1967) for comparing periodontal status in different races of people was employed in dogs and cats, and gave a Periodontal Index (P.D.I.) for each patient. The simplified scoring system for measuring dental plaque and calculus used by Rosenberg & Ash (1974) slightly modified, was employed to give an Irritation Factor (I.F.) i.e. combined plaque and calculus and also for calculus independant of plaque, the Calculus Index (C.I.). The following instruments were used, Ash De Trey No. 4

mouth mirror; Williams 14W and Ash No. 2 pocket measuring probes; Ash upper molar type dental forceps and Gray's pattern mouth gags. The recorded data were used to create data files in the Edinburgh Regional Computing Centre; programmes from "Statistical Packages for Social Sciences" were used for retrieval and statistical analysis.

RESULTS - DOG

Three hundred and thirty two pure bred dogs were examined during the two year period, 83 had clinical periodontal disease (dental cases), 249 were admitted for other surgical therapy or examinations (non-dental cases). Thirty six of the patients had had previous treatment for periodontal disease, Table 1.

The ages of the animals ranged from six months to 16 years, Table 2, and the sex ratios are given in Table 3.

Fifty one breeds of dogs were represented and are listed in Table 4 with the respective numbers. The dogs ranged in weight from less than 2.5 kilogrammes to over 50 kilogrammes, the weights were divided into twelve groups for convenience of analysis. Tables 4 and 5.

The mean age of non-dental cases 6.1365 years, S.D. 4.1974, differed significantly from those with P.D. 9.3253 years, S.D. 2.9138, P = 0.0000, Table 6. A similar significant statistical difference was noted between the ages of dogs with no previous P.D. therapy and those which had, 6.50 years, S.D.. 4.09 and 10.47 years, S.D. 2.70, P = 0.0000, Table 7.

Periodontal Disease Index

The Periodontal Disease Index (P.D.I.) for the population ranged from 0.00 to 5.17 (possible maximum 6), with mean 1.599(S.D. 1.169). P.D.I. by age is shown in Table 8 which also gives the statistical analysis of variance, indicating a highly significant difference between the age groups, with good linearity i.e. severity increased with increase in age.

Table 5 gives P.D.I. data for dogs in the twelve weight groups, statistical analysis showed a highly significant difference between the groups and good negative linear correlation suggesting decrease in P.D.I. with increase in body size. There was no significant difference in P.D.I. between the four sex divisions, P = 0.0981, (Table 9).

P.D.I. data from the non-dental patients was very significantly different from data from dental patients, P = 0.0000, as were the data from dogs with no dental history and those with, P = 0.0000. (Tables 6 and 7). The P.D.I. data and statistical analysis for each breed of dog, Table 10, showed a distinct breed difference which was highly significant, P = 0.0000.

Irritation Factor (Plaque & Calculus) (I.F.)

The dental deposit or Irritation Factor (I.F.) for the population ranged from 0.00 to the possible maximum 3.00, mean 1.923, S.D. 0.728.

I.F. data by age (Table 8) and by weight (Table 5) were significantly different between the respective groups, P = 0.0000 for each, with good positive linearity for the age data and good negative linearity for the weight figures.

A highly significant difference was noted for the breed data, P = 0.0000, but no significant difference between sexes, P = 0.0693. (Tables 10 and 9).

Again I.F. differed significantly between the non-dental and dental cases, P = 0.0000 and between dogs without and with previous periodontal therapy, P = 0.000. (Tables 6 and 7).

Calculus Index (C.I.)

Deposits of dental calculus measured separately from the total deposits for the population scored from 0.000 to 3.000 the maximum possible, with mean 0.776, S.D. 0.815. C.I. for the separate breeds is given in Table 10.

The C.I. by age (Table 8) and for the weight groups (Table 5) were statistically significantly different, P = 0.0000 for each criterion, with good positive linearity for the age data, and negative linearity in the weight data. No significant difference was observed in the sex data, P = 0.1067, (Table 9).

C.I. for non-dental and dental patients differed significantly, P = 0.000, as did that for those which had no previous dental therapy and those which had, P = 0.0000. (Tables 6 and 7).

Comparison Between P.D.I., I.F., and C.I.

Pearson correlation co-efficients showed a high correlation between the three factors (Table II). Higher mean indices particularly P.D.I. were observed at the canine, premolar and molar areas.

Table 12 gives the mean indices for the dental arcade segments for upper and lower jaws and demonstrates the significant difference between the data for maxillary and mandibular areas and between the different segments of the arcades.

Diet: P.D.I., I.F. and C.I.

Accurate details of diet were ascertained for 311 of the dogs examined.

Diets seldom comprised of one component only; the majority of the dogs were given a meat staple with biscuit mixed or fed separate from the meat, 190 received canned meat while most of the remaining 121 dogs had cooked or raw fresh meat or a mixture of canned and fresh, with very few having commercially prepared whole diet mixtures, fish or household food.

Approximately half of the 311 dogs - 157 - also had "chews" on a regular basis i.e. they were available always and replaced when required. The 'chews' were bones, rawhide or super-hard baked biscuit.

The statistical significance of the data relating to the main diets and P.D.I., I.F. and C.I. are listed in Table 13. The type of meat did not affect the degree of periodontitis (P.D.I.), volume of dental deposit (I.F.) nor the accumulation of calculus (C.I.); addition to the diet of biscuit "mixers" did not alter this. On the other hand "chews" did have an important influence in that dogs which had regular access to them had highly significant lower P.D.I., I.F. and C.I. values, Table 14.

L.S.D. and Scheffe statistical tests at 95 per cent confidence levels did not indicate that any one "chew" was much superior to any of the others: however, super-hard biscuit was associated with lower mean P.D.I.; bone with lower mean I.F. and C.I. while super-hard biscuit also influenced I.F. and C.I. though to a lesser degree than bone.

RESULTS - CATS

Fifty two cats were examined during the period of study, 40 were non-dental patients, 12 were treated for periodontal disease. Only one cat had had previous dental therapy. Table 15.

The cats' ages ranged from six months to 15 years, the numbers in each age group are given in Table 16. The sex distribution is shown in Table 18. Body weights ranged from 2 to 6.5 kilogrammes, the numbers in three weight groups are listed in Table 17.

Cats were not defined by breed nor type.

Periodontal Disease Index (P.D.I.)

P.D.I. for the population ranged from 0.00 to 3.00; mean 1.78 S.D. 0.767. The data for age (Table 16) was significantly different statistically between the groups, P 0.0316 with significant positive linearity. A similar pattern was seen between the weight groups P = 0.0122 and P = 0.0092.

Analysis of P.D.I. data for the four sex groups given in Table 18 showed a very significant difference between the groups, P = 0.0000.

Mean P.D.I. for patients with non-dental diseases and for those with clinical periodontal disease are listed in Table 19, analysis gave a highly significant difference between the groups P = 0.0000.

Irritation Factor (I.F.) (Plaque & Calculus)

The range for the population was 0.00 to 3.00 mean 1.788, S.D. 0.746. I.F. indices for cats in age groups (Table 16) when analysed did not show a clearly significant difference between them, P = 0.0651, although the linearity was good. Analysis of data between the weight groups (Table 17) showed a highly significant difference with good positive linearity.

A highly significant difference, P=0.0000 was found between the sex groups (Table 18). The I.F. score data for non-dental and dental cases differed significantly, P = 0.0062. (Table 19).

Calculus Index (C.I.)

The C.I. for the population ranged from 0.00 to 3.00, mean 0.585, S.D. 0.539. Indices for the age group sub-populations differed highly significantly, P = 0.0000, with excellent positive linearity, P = 0.0000, Table 16. Data from the non-dental cats differed very significantly from the dental cats, P = 0.0000. Table 19.

Correlation of P.D.I., I.F. and C.I.

As in the dog a strong correlation was noted between P.D.I., I.F. and C.I.

The apparent anomally regarding the analysis of P.D.I., I.F. & C.I. in the sex and weight groups, compared with the dog led to farther examination of these data.

The average age of entire male and entire female cats was 1.17 and 3.08 years respectively, while the average ages for neutered animals were 7.89 and 8.86 years, which suggested that age was the factor influencing the lower mean P.D.I., I.F. and C.I. in entire animals. (Table 18a).

Heavier i.e. larger cats should have had lower mean indices if compared to dogs. Analysis of the ages of cats in the three weight groups gave respective mean ages of 3.25, 6.4286 and 8.80 years, P = 0.0017,(Table 17a) and again would relate higher P.D.I., I.F. and C.I. to increase in age rather an association with body size when the three indices would have been lower in the heavier groups.

Diet: P.D.I., I.F. and C.I.

Cats were expected to be more conservative in their eating habits than dogs, but although the majority received canned meat all the cats examined also had high and varying proportions of raw or cooked meat and fish. That pattern of feeding precluded grouping of diets according to a main or sole constituent.

Cats in this study did not have biscuit supplement or "mixers" although a few were given "tit-bits" of proprietory prepared whole dry food, but not in the quantity nor frequency expected to have influenced their periodontal status.

None of the diet groupings was associated with statistical differences in P.D.I., I.F. nor C.I. data within 95 per cent confidence limits.

None of the cats were provided with "chews" and very few owners were sure if nor how often their pets caught or ate small prey which may be the feline equivalent.

DISCUSSION

Gingivitis and periodontal disease in dogs and cats appeared to be ubiquitous in the population studied, (Tables 8 & 10). A very small number had zero or miminal P.D. Indices and these were mainly young animals whose permanent dentition had been completed recent to examination or occasional less young animals of large breeds of dog. Those dogs and cats also had minimal dental

deposit scores. The disease was prevalent albeit at sub-clinical level in patients which were seen for non-dental problems (Table 6). No specific criteria were established for defining the difference between non-clinical and clinical periodontal disease, apart from owners noticing "halitosis", oral bleeding or difficulty in mastication. It was evident that many of the non-dental patients were in need of oral therapy. Close correlation between P.D.I., I.F. and C.I. (Table 11) demonstrated a strong association between the amount of dental deposits and the degree of periodontal disease, consequently it was noted that P.D.I. increased linearly with age (Tables 8 and 16). Presumably the more deposit and the longer it was present there was a greater likelihood of periodontal disease to develop and increase in severity, supporting the contentions of Gray (1923, 1926), Wright (1939), Fiennes and Fiennes (1969), Brown & Park (1969) and many others. In man it was suggested that the strong correlation of periodontal disease with age probably reflected the cummulative effects rather than diminishing resistance in older people and that the length of time the tissues were exposed to dental plaque was important in the development of periodontal destruction (W.H.O. Technical Report, 1978).

It has been thought that female dogs and cats were less prone to periodontal disease than males, this again may have been an extrapolation from the human situation where the W.H.O. Technical Report (1978) stated that in most surveys women were found to have a lower severity of P.D. than men. This was not so in dogs where no statistical difference was seen between the four sex groups, nor in the age corrected data from cats (Tables 9 and 19, 19a). Possibly women are more fastidious than men with regard to oral hygiene, but domesticated animals are complete populations which are managed similarly.

The results obtained in this study for dogs regarding the reducing severity of periodontal disease with increasing body weight (Table 5) i.e. size of the animal, were reflected in the breed prevalence, (Table 10), so that the smaller breeds, particularly those of the Toy Group, were at greater risk of developing P.D. early in life, of showing increasing severity sooner and were more prone to tooth loss. The shape and relative size of skull and jaws must obviously have played some part in the predisposition to clinical P.D., brachycephalic breeds and those with "squarer" muzzles were less favoured than those with more normal, longer skulls and jaws: however there were some exceptions and farther studies in this area would be desirable. The results from cats, whose body size and skull anatomy did not show such great variation as dogs, were less easy to reconcile regarding P.D. severity to body weight, the main influence appeared to be the length of time that their gingivae were exposed to dental deposits (Tables 17, 17a & 16).

Table 12 shows the validity of Colyer's (1947) observation regarding greater severity of P.D. in upper than in lower jaws in dogs. This applied also in cats.

The highly significant difference between P.D.I., I.F. and C.I. of non-dental and dental patients was expected and would seem to have been associated with the age factor in dogs and cats and possibly with body size in dogs, (Tables 6, 19 & 5). The question of when sub-clinical P.D. became a clinical problem remained unanswered, with the apparent need for therapy in many of the non-dental cases one must assume that dogs and cats reach a state or age at which they manifest clinical signs or behaviour which is recognised by owners or veterinary surgeons. On the other hand owners may not be aware of the importance of the signs till the disease is at an advanced stage. Again, the highly significant difference between the age, P.D.I., I.F. and C.I. of those dogs which had not or had previous periodontal therapy (Table 7) may have been purely age, breed or size dependant. The age distribution and linear increase in severity of P.D. in dogs and cats and the recurrent nature in dogs suggested continuing susceptibility and aetiological factors and that the disease was progressive.

The WHO Technical Report (1978) stated that there was little evidence as yet to implicate nutritional excesses or deficiencies in chronic periodontal disease in man, even as modifying factors, and that moderate changes in diet consistency did not seem to affect plaque accumulation. Table 13 indicated that the diets of dogs in this survey did not influence P.D.I., I.F. nor C.I. significantly one from another. The fact that there was an over-all continuing and increasing severity of P.D. suggested that although the nutritional value of the food might have been adequate it certainly did nothing to reduce the hazzards of P.D. These findings along with modern concepts of P.D. aetiology (Page & Schroeder, 1982; Van Pallenstein Helderman 1981) tended to invalidate Mellanby's (1932) conclusions for spontaneous clinical P.D. and lend support to Gray, (1923, 1926); Wright (1939); Colyer (1947); Edney (1982), and many others. Likewise none of the foods fed to cats influenced the prevalence of P.D.I. & I.F. nor the increasing severity of P.D. It is interesting to note in Table 12 that the higher indices were at the canines, which have become largely obsolete anyway in domestic dogs, and at the sectorial divisions - the premolar and molar areas. The upper third and fourth premolars with the upper first molars (and to some extent the upper second molars) apposed to the lower fourth premolars and the lower first and second molars form composite shearing,

masticatory units in most breeds of dogs. High P.D.I., I.F. and C.I. in the premolar and molar segments might again indicate a degree of obsolescence because of the types of food which dogs are given, exacerbated by gnathic bone abnormalities in some other breeds

Table 14 shows the strong beneficial effect of "chews" on P.D.I., I.F. and C.I. in the dogs studied. Brown and Park (1969) demonstrated a similar pattern for dental calculus, while Gray (1923, 1926) wrote that food which required to be masticated as opposed to just swallowed would also reduce the incidence of periodontal problems in dogs and cats. Colyer's (1947) views have been exposed already. There are problems associated with including "chews" in the diet of dogs, Fiennes and Fiennes (1969) and Gray (1923; 1926) observed that smaller dogs with finer or weaker jaws were reluctant to eat hard materials and consequently suffered more severe periodontal disease. It has also been observed clinically in man, that reduced masticatory function usually led to increased plaque and dental calculus formation, (W.H.O. Technical Report 1978). Gray contended, however that if dogs were introduced to firmer food early in life even the smaller breeds could cope and benefit. It is known clinically that continual bone chewing is one of the major causes of dental attrition in dogs, where even in early middle age some dogs will have worn their tooth crowns to gum level. Many dogs also which have irregular access to bone develop very severe blockage of the rectum and colon requiring surgical intervention for relief. Brown and Park (1969) did not mention these problems in their Beagles, so if bone is the "chew" of choice it probably should be included in a controlled pattern. Neither of these features of dental attrition or rectal blockade seemed to be associated with super hard biscuit which scored well in this study, therefore it might be preferred to bone, or alternated with bone and/or rawhide.

There is no scientific evidence from this survey that firmer diets or the inclusion of hard commercially prepared whole foods would be equally beneficial in reducing P.D. in cats, but one would think, intuitively, that the opinions of Gray (1923 & 26) and Colyer (1947) may be justified in this respect.

Summary and Conclusions

Periodontal disease was common to all ages of dogs and cats apart from the very young, and was more prevalent and severe in small dogs. The severity increased with increasing age and eventually surgical therapy was required by most patients. If the aetiology is understood correctly, dental deposits - plaque and calculus, - which were strongly correlated statistically with P.D. were the principal cause despite conjecture as to which of the plaque bacteria or their products were responsible ultimately for periodontal pathology. Dental calculus alone was unlikely to have been the initiating factor.

It was evident, as in man (W.H.O. Technical Report 1978), that the amount of dental deposit which can be accumulated or tolerated varied from individual to individual. This was remarked in breeds with high P.D.I. and in those with low indices; this factor also would be an interesting field for farther study.

Modern methods of feeding dogs and cats did not appear to be an improvement as far as dental health was concerned, observers may argue that P.D. was less severe than when described by Gray in 1923 and 1926, but currently the effects of P.D. and the clinical signs are allayed or masked by the administration, for convenience or lack of understanding, of systemic antibacterial therapy. Increased masticatory function might be improved, by changing the consistence of diets or by offering chewing material, to great advantage in controlling periodontal problems. There does not seem to be any method, at present, to simulate in dogs or cats, the protocols of oral hygiene undertaken in man. The marketing of a canine dentifice some decades ago was a failure, the patients did not permit having their teeth brushed regularly and owners could not or would not attempt to do so for very long.

It would appear that the veterinary surgeon - patient approach to reducing periodontal disease in dogs and cats is largely ineffective and that people have come to accept that P.D. is inevitable. A significant part of canine and feline veterinary surgery is taken up with dental therapy, removing dental calculus and/or extracting loose teeth or those showing excessive root exposure, i.e. dealing with a chronic longstanding situation.

Accumulated knowledge has provided a rational explanation of the aetiology and progress of periodontal disease in man which seem to be paralleled in the dog and cat, so it should not be too difficult to devise schemes of prevention. Serious consideration might be given to modifying diets by including elements to increase masticatory function and also to re-orientating the provision of veterinary dental care towards early preventative treatment rather than palliation when periodontal disease has reached a terminal stage.

References:

Bell, A.F., 1965, Dental disease in the dog. J. Small Anim Pract 6 : 421 - 428.

Brown, M.G. & Park, J.F., 1968, Control of dental calculus in experimental Beagles. Lab Anim Care 18(5) : 527 - 535.

Colyer, F. 1947, Dental disease in Animals. Br. dent. J., 82 : 2 - 10, 31 - 35.

Edney, A.T.B., 1982, Ed. Dog and Cat Nutrition Pergamon Press, Oxford, England.

Fiennes, R. and Fiennes, A., 1968. The World Naturalist : The natural history of the dog. Weiderfield and Nicolson, London.

Gray, H. 1923. Pyorrhoea in the dog. Vet.Rec. 3 vol iii : 167 - 169.

" " 1926. Pyorrhoea in the dog and cat. Proc. nat Vet Med Assoc. July 1926 : 183 - 198.

McPhee, I.T., 1972. Ed. Host Resistance to Commensal Bacteria. The response to dental plaque. Churchill Livingstone, Edinburgh.

Mellanby, May, 1930. Diet and the teeth, An experimental study. Part IIA, Diet and dental disease. Medical Research Council Special Report No. 153.

Page, P.C. and Schroeder, H.E., 1982. Periodontitis in Man and Other Animals. A Comparative Review. Karger, London & New York.

Ramfjord, S.P., 1967. The Periodontal Disease Index (P.D.I.). J. Periodontol, 38 : 602 - 610.

Rosenberg, R.M. and Ash, M.M.Jnr., 1974. The effect of root roughness on plaque accumulation and gingival inflammation. J. Periodontol 45 : 146 - 150.

Van Pallenstein Helderman, W.H., 1981. Microbial aetiology of periodontal disease (review article). J. clin. Periodontol 8 : 261 - 280.

W.H.O. Technical Report Series 621 1978. Epidemology, aetiology and presentation of periodontal disease. Report of a W.H.O. Scientific Group. World Health Organisation, Geneva, Switzerland.

Wright, J.G., 1939. Some observations on dental disease in the dog. Vet. Rec. 51 : 409 - 421.