Get It For Me Pull Slip

Request Date: 12/6/2012 1:33:37 AM

Journal Title: Journal of Veterinary Dentistry

Volume: 13
Issue: 3
Month/Year: Sep 1996

Article Author: Harvey CE, Shofer FS, Laster L.
Article Title: Correlation of diet, other chewing activities and periodontal disease in North American client-owned dogs.

Pages: 101-5

Location: MSL Bound Journal Stacks
Call Number:

* UPDATE LOANsONE DOC:

Customer Information: yourpetsfriend@gmail.com

Copyright Notice: This material may be protected by Copyright law (Title 17 U.S. Code)

Unable to pull because: (initial & date)
1. Volume Not On Shelf
2. Title Not On Shelf
3. Not Found As Cited/Other

**Bring item down & place in Borrowing Problem Box in room 142.
Correlation of Diet, Other Chewing Activities and Periodontal Disease in North American Client-Owned Dogs

Colin E. Harvey, BVSc
Frances S. Shofer, PhD
Larry Laster, PhD

Summary: In 1350 client-owned dogs in North America, the association of calculus, gingival inflammation and periodontal bone loss with diet (dry food only, or other than dry food only), and with access to other chewing materials was analyzed. There were few apparent differences seen in dogs fed dry food only compared with those fed other than dry food only. There was progressively less accumulation of calculus, less gingival inflammation and less periodontal bone loss in dogs that were given access to more types of chewing materials (rawhides, bones, biscuits, chew toys) compared with dogs given access to fewer or no chewing materials. When the effects of individual chewing materials were analyzed, access to rawhides overall had the greatest apparent periodontal protective effect, and this effect was more apparent in dogs fed dry food only compared with those fed other than dry food only. J Vet Dent 13(3); 101-105, 1996

Introduction
Periodontal disease (gingivitis, periodontitis) results from the accumulation of plaque and calculus on teeth. It can be prevented by thorough and frequent brushing of the teeth of dogs1. Wild canids have less periodontal disease than domesticated dogs, presumably because their diet is more effective in preventing accumulation of plaque and calculus2. There have been many anecdotal reports and some analytic studies that comment on the relationship between extent of periodontal disease and diet in dogs, which were recently reviewed in detail3. Generally, these studies suggest that a diet other than dry food results in more plaque on the teeth, and hence slow the development of periodontal disease.

Recently, we reported the overall extent of calculus deposition, number of missing teeth, and periodontal disease (gingival inflammation, mobility, furcation involvement and attachment loss) and their associations with age and body weight in 1,350 North American dogs4. Here, we report on the relationships among calculus, periodontal disease (gingival inflammation and evidence of bone loss) and diet and other chewing activities, using data from the same epidemiological survey of client-owned dogs.

Materials and Methods
All dogs were examined while under general anesthesia at hospitals staffed by Fellows of the Academy of Veterinary Dentistry*. The oral examination process and recording system were described previously4. A detailed dietary, chewing habit, dental care, and environmental history was obtained from the owners (Table 1).

Statistical Analysis
Data were analyzed by several methods. For some analyses, a score was created for extent of calculus, gingivitis, and periodontal attachment loss. The score for each index was the average score for the five teeth for which calculus accumulation, gingival index, and attachment loss were measured; these were the mandibular canine, mandibular first molar, maxillary canine, maxillary first molar, and maxillary fourth premolar teeth. The total of the scores for individual teeth was divided by the number of teeth present to determine the total score for that index for that dog. Scores for the calculus and gingival indices were 0-3. In an attempt to take account of periodontal attachment being weight and tooth dependent4, and dogs of smaller body weight

Table 1 - Diet and chewing material information obtained for each dog

<table>
<thead>
<tr>
<th>On a typical day, the dog is fed:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>can(s) of dog food</em></td>
<td></td>
</tr>
<tr>
<td><em>cup(s) of soft-moist dog food</em></td>
<td></td>
</tr>
<tr>
<td><em>cup(s) of dry dog food</em></td>
<td></td>
</tr>
</tbody>
</table>

If dry food is fed as the only or a major part of the diet, is it _fed dry_ _fed moistened_

Number of whole dog biscuits fed

Table scraps are the major food source

Table scraps are a minor part of the diet

There is no "typical diet"_

Chew treats or toys: Does the dog regularly get and chew on any of the following (check all that apply):

- Rawhide strips (any shape or size)
- Large gnawing bones (real bone)
- Plastic, rubber or nylon chew toys
- Fibrous (nylon or cloth) chew toys
- Others - describe

* The data reported here were collected at veterinary hospitals of the following Fellows of the Academy of Veterinary Dentistry: James Anthony, DVM; James Aavil, DVM; Randi Brannan, DVM; Benjamin H. Colmery, DVM; Joseph F. Cukjati, DVM; Thomas J. Cusick, DVM; Andrew Duke, DVM; Edward R. Eisner, DVM; Gary Goldstein, DVM; Steven E. Holmstrom, DVM; Kenneth F. Lyon, DVM; Donald E. McCoy, DVM; Christofel J. Visser, DVM. Particular thanks go to Dr. E. Eisner and his hospital staff for their contribution.

From the Department of Clinical Studies, School of Veterinary Medicine, University of Pennsylvania, 3900 Delancey Street, Philadelphia, PA 19104-6010.

J. VET. DENT. Vol. 13 No. 3 September 1996
having proportionately larger teeth than larger dogs, a tooth-weight factor (Table 2) was calculated using the following equation: “attachment loss” score = 4 x (attachment loss/tooth-weight factor) and then divided by the number of teeth present.

For each of the individual index scores (calculus, gingival inflammation, attachment loss), a two-way analysis of covariance (on age) was used to examine the interaction between dietary/chewing habits (“chew score”) and weight group (<7kg, 7-14kg, 15-28kg, >28kg). The “chew score” was calculated by summing the number of chewing items each owner indicated the dog had access to. These were: bones; rawhides; biscuits; fiber chew toys; and plastic, rubber or nylon chew toys. The chew score ranged from 0 to 5. Since the sample size of dogs with a chew score of 4 or 5 was small (n=43), chew scores 4 and 5 were combined with chew score 3 for analysis.

Logistic regression was used to relate independent risk factors with presence or absence of calculus, gingivitis, furcation, mobility, and attachment loss. For purposes of this type of analysis, calculus and gingivitis, which were scored on an index of 0-3, were grouped into two categories (0-1 or 2-3) and mean attachment loss was grouped into 0-0.25 or >.25mm. These analyses were used to determine the relative importance of the various items chewed in relation to one another. The five teeth analyzed in this manner were mandibular canine and first molar teeth, and maxillary canine, fourth premolar teeth and first molar teeth (no analysis of furcation for canine teeth). An analysis comparing dogs fed dry food only and those not fed dry food only was performed, including age and weight as independent variables. For other chewing materials, independent factors tested for inclusion in each tooth-index analysis were weight, age, chewing of rawhides, bones, biscuits, and toys (includes rubber, plastic, nylon or fiber). Separate analyses were performed for dogs fed dry food only versus dogs not fed dry food only. Modeling was accomplished by backward elimination. Data are presented as odds ratios (ORs) for the model of best fit. An OR >1 represents an increase in risk of disease, and an OR <1 represents a decrease or reduction in risk.

Analyses were performed using SAS® (analysis of covariance) and BMDP (logistic regression) software. A p<0.05 was considered statistically significant.

### Results

**Calculus index/chews score and body weight analysis:**
There is a statistically significant linear relationship between decreasing calculus score and access to an increasing number of chewing materials, and increasing calculus score with decreasing body weight (Fig.1). For each of the four body weight groups, the relationship between calculus score and chew score is linear (p = 0.005, 0.0001, 0.03, 0.02 respectively for 0-6, 7-14, 15-28 and >28kg body weight).

**Gingival index/chew score and body weight analysis:**
Although it is less obvious than for calculus index, the trend is for less gingival inflammation as access to additional chewing materials increases, with a statistically significant linear relationship between decreasing gingival

### Table 2. Tooth-Weight Factor

<table>
<thead>
<tr>
<th>Body Weight Group</th>
<th>Max C</th>
<th>Max P4</th>
<th>Max M1</th>
<th>Mand C</th>
<th>Mand M1</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;7kg</td>
<td>15</td>
<td>10</td>
<td>8</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>7-14kg</td>
<td>20</td>
<td>13</td>
<td>10</td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td>15-28kg</td>
<td>25</td>
<td>16</td>
<td>14</td>
<td>25</td>
<td>16</td>
</tr>
<tr>
<td>&gt;28kg</td>
<td>30</td>
<td>20</td>
<td>17</td>
<td>30</td>
<td>20</td>
</tr>
</tbody>
</table>

Max = maxillary, Mand = mandibular jaw. C = canine, P = premolar, M = molar teeth

---

**Figure 1. Chart showing differences in mean calculus index among dogs with access to differing chewing materials and with differing body weights.**

**Figure 2. Chart showing differences in mean gingival index among dogs with access to differing chewing materials and with differing body weights.**
Figure 3. Chart showing differences in periodontal attachment loss among dogs with access to differing chewing materials and with differing body weights.

index with access to an increasing number of chewing materials except for dogs 0-6kg (p = 0.2, 0.0001, 0.006, 0.001 for 0-6, 7-14, 15-28 and >28kg body weight, Fig. 2).

Attachment loss/chew score and body weight analysis: Although there is a statistically significant linear relationship between decreasing attachment loss with increasing chewing activity only for dogs 7-14kg (p = 0.001, 0.06, 0.3 and 0.2 for dogs 0-6, 7-14, 15-28 and >28kg, Fig. 3), the trend is for less attachment loss with access to increasing numbers of chewing materials.

Comparison of dogs fed dry food only with those not fed dry food only (Table 3). There are statistically significant increases with age and decreases with increasing body weight for calculus index, gingival index, attachment loss (except for maxillary and mandibular first molar teeth), and furcation and mobility. However, there are few statistically significant differences for calculus index, gingival index, attachment loss and furcation when comparing dry food only and non-dry food only fed dogs, and there is no pattern to the trends (some teeth show an apparent protective effect from feeding dry food only, and others show the opposite - for calculus index, the trend is protective for all five teeth in dogs fed dry food only, whereas for gingival index it is the opposite, and it is mixed for attachment loss). All maxillary teeth are significantly less likely to be mobile in the dry food only group, yet the mandibular first molar tooth showed the opposite effect.

Table 3: Logistic Regression Analysis - Effect of Age, Body Weight, and Feeding of Dry Food on Periodontal Indices

<table>
<thead>
<tr>
<th>Index</th>
<th>Tooth</th>
<th>Age</th>
<th>Weight</th>
<th>Dry Food Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculus Index</td>
<td>UM1</td>
<td>1.106*</td>
<td>0.990*</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>UP4</td>
<td>1.107*</td>
<td>0.990*</td>
<td>0.86*</td>
</tr>
<tr>
<td></td>
<td>UC</td>
<td>1.169*</td>
<td>0.981*</td>
<td>0.78</td>
</tr>
<tr>
<td></td>
<td>LC</td>
<td>1.198*</td>
<td>0.978*</td>
<td>0.70*</td>
</tr>
<tr>
<td></td>
<td>LM1</td>
<td>1.150*</td>
<td>0.987*</td>
<td>0.78</td>
</tr>
<tr>
<td>Gingival Index</td>
<td>UM1</td>
<td>1.108*</td>
<td>0.991*</td>
<td>1.34*</td>
</tr>
<tr>
<td></td>
<td>UP4</td>
<td>1.148*</td>
<td>0.992*</td>
<td>1.11</td>
</tr>
<tr>
<td></td>
<td>UC</td>
<td>1.127*</td>
<td>0.991*</td>
<td>1.06</td>
</tr>
<tr>
<td></td>
<td>LC</td>
<td>1.115*</td>
<td>0.989*</td>
<td>1.08</td>
</tr>
<tr>
<td></td>
<td>LM1</td>
<td>1.113*</td>
<td>0.990*</td>
<td>1.06</td>
</tr>
<tr>
<td>Attachment loss</td>
<td>UM1</td>
<td>0.997</td>
<td>0.987*</td>
<td>1.07</td>
</tr>
<tr>
<td></td>
<td>UP4</td>
<td>1.064*</td>
<td>0.980*</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>UC</td>
<td>1.070*</td>
<td>0.991*</td>
<td>0.92</td>
</tr>
<tr>
<td></td>
<td>LC</td>
<td>1.062*</td>
<td>0.992*</td>
<td>1.02</td>
</tr>
<tr>
<td></td>
<td>LM1</td>
<td>1.013</td>
<td>0.968*</td>
<td>0.96</td>
</tr>
<tr>
<td>Furcation</td>
<td>UM1</td>
<td>1.185*</td>
<td>0.973*</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>UP4</td>
<td>1.192*</td>
<td>0.971*</td>
<td>0.71</td>
</tr>
<tr>
<td></td>
<td>LM1</td>
<td>1.161*</td>
<td>0.956*</td>
<td>0.75</td>
</tr>
<tr>
<td>Mobility</td>
<td>UM1</td>
<td>1.134*</td>
<td>0.959*</td>
<td>0.56*</td>
</tr>
<tr>
<td></td>
<td>UP4</td>
<td>1.121*</td>
<td>0.907*</td>
<td>0.26*</td>
</tr>
<tr>
<td></td>
<td>UC</td>
<td>1.133*</td>
<td>0.872*</td>
<td>0.38*</td>
</tr>
<tr>
<td></td>
<td>LC</td>
<td>1.123*</td>
<td>0.874*</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>LM1</td>
<td>1.147*</td>
<td>0.955*</td>
<td>1.18</td>
</tr>
</tbody>
</table>

Data presented as odds ratios, *p<.05
U= upper, L= Lower; C= canine, P= premolar, M= molar teeth

Calculation index - effect of individual chewing materials (Fig. 4): In the group fed dry food only, access to rawhide chews is significantly associated with reduced accumulation of calculus for four of the five teeth examined, and for three of five teeth in dogs given access to chew toys. Only the mandibular canine tooth shows a protective effect from access to bones, and biscuits are not associated with a significant protective effect on any of the five teeth. There are fewer statistically significant

Figure 4. Chart showing associations of calculus index among dogs with access to specific chewing materials for different teeth. Results are shown only for statistically significant (p < 0.05) associations, and are shown as odds ratios - a negative odds ratio indicates a periodontally-protective effect. Figure 4A - for dogs fed dry food only. Figure 4B - for dogs not fed dry food only.
associations between calculus index and access to chewing materials in dogs not fed dry food only (Fig. 4 B): only the maxillary and mandibular canine teeth (for rawhides), the maxillary fourth premolar and first molar teeth (for chew toys), and the maxillary first molar tooth (for bones) show a protective effect.

**Gingival index - effect of individual chewing materials** (Fig. 5): In the dry food only group, access to rawhide chews is significantly associated with less gingival inflammation for all five teeth examined, for four of the five teeth in dogs given access to chew toys, for three of the five teeth in dogs given access to bones, and for two teeth in dogs given access to biscuits (Fig. 5A). There is a significant protective effect for the maxillary first molar and fourth premolar, mandibular first molar and canine teeth from access to three of the materials, and a similar effect for the maxillary canine teeth from access to two of the materials. There are fewer statistically significant associations among dogs not fed dry food only: only the maxillary and mandibular molar teeth (for both rawhides and biscuits), and the mandibular first molar teeth (for chew toys) show a protective effect (Fig. 5B).

**Attachment loss - effect of individual chewing materials** (Fig. 6): In the dogs fed dry food only, access to rawhide chews or chew toys is associated with a significantly lower risk of attachment loss for all five teeth examined, and no teeth show a protective effect from access to any of the other materials. In the group not fed dry food only, access to chew toys or bones is associated with a significantly lower risk of attachment loss for the maxillary first molar tooth.

For the mobility and furcation exposure data, there are no protective effects demonstrated for any of the teeth from access to any of the chewing materials except for the maxillary fourth premolar tooth in non-dry food dogs give access to biscuits; however, there are only 5-48 dogs in any of the furcation- or mobility-positive groups.

Overall, the data in Figures 4-6 show a trend towards there being a more wide-spread protective effect when additional chewing materials are made available in dogs fed dry food only, compared with non-dry food fed dogs. For calculus index, eight of 20 associations of chewing material/tooth are significantly protective for dry food fed dogs, as are five of 20 associations for non-dry food fed dogs. For gingival index, the pattern is similar but more obvious - 14 of 20 protective associations for dry food fed dogs, and only five for non-dry food fed dogs. For attachment loss, the pattern is five of 20 associations in dry food fed dogs compared with two of 20 in non-dry food dogs. However, the furcation and mobility data do not follow this trend, with no correlations for furcation exposure in the dry food group and only one in the non-dry food group for each index (though as noted above, the number of furcation or mobility positive teeth was very low). A detailed data set

---

**Figure 5a.** Chart showing associations of gingival index among dogs with access to specific chewing materials for different teeth. Results are shown only for statistically significant (p < 0.05) associations, and are shown as odds ratios - a negative odds ratio indicates a periodontally-protective effect. *Figure 5A - for dogs fed dry food only. Figure 5B - for dogs not fed dry food*

**Figure 6a.** Chart showing associations of attachment loss among dogs with access to specific chewing materials for different teeth. Results are shown only for statistically significant (p < 0.05) associations, and are shown as odds ratios - a negative odds ratio indicates a periodontally-protective effect. *Figure 6A - for dogs fed dry food only. Figure 6B - for dogs not fed dry food*
Discussion

The data reported here were obtained from a large number of dogs compared to populations of dogs in laboratory-based studies. However, the epidemiological nature of the study necessitated inclusion of many variables. As noted from the previously reported data from this study, results were recorded by several recorders at several veterinary hospitals. Thus this study should be considered as providing indications of trends rather than definitive conclusions, even when the results are statistically significant. Factors that may have significant influence, and which were not included in the regression analyses, are whether the teeth were brushed or not, and whether the teeth had been scaled in the year or two prior to examination.

The data for chewing materials are based on whether owners reported providing specific chewing materials for their dogs, not whether the dog actually chewed them, or how or for how long they chewed them. In a study of the effect of rawhide chews on accumulation of plaque and calculus, dogs were videotaped and divided into “fast” and “slow” chewers - the “slow” chewers had less accumulation of calculus at the end of the 12 month trial period than the “fast” chewers. In addition, the fast chewers had less calculus accumulation than the control (no rawhide) group.

There is considerable variation in the effect of variables (diet and chewing materials) among teeth. This makes the consistent findings more obvious, and perhaps more important, as indicators of trends that demonstrate or suggest protective effects. The data for age and weight associations are useful indicators of relevance, because they are so consistent for the teeth involved and for the index under examination; using this criterion, we are unable to demonstrate that dry food has a consistent periodontal protective effect; whereas rawhide chews and bones are moderately effective chewing agents. The only tooth that was not found to have a statistically significant relationship between chew score and extent of calculus was the mandibular first molar tooth, which develops less calculus than the other teeth examined.

These results demonstrate that statistically significant periodontal protective effects can be obtained by providing access to chewing materials. However, the inconsistent results associated with specific chewing materials suggest that it will be impossible to consistently forecast the effect of particular chewing materials on individual animals. As an example of the inconsistency, access to bones is associated with decreased calculus and gingival indices, increased mobility and mixed (two teeth increased, one decreased) furcation results for the maxillary fourth premolar and first molar teeth and the mandibular first molar tooth. Continuing follow-up professional examination is therefore strongly recommended, even when an apparently optimal combination of agents is provided.

The results of analyses of the effects of a dry food only diet are also inconsistent. Dry food is believed to have a somewhat effective dietary abrasive effect compared with feeding a non-dry food diet, though we are unable to demonstrate such an effect in this very varied group of dogs. If dry food is itself somewhat periodontally protective compared with a non-dry food only diet, it seems odd that dogs fed dry food only were more likely to demonstrate a protective effect when other chewing materials were made available. Perhaps dogs fed dry food are more naturally (or by owner selection) chewers.

The mixed results for any one class of product examined here, and the finding that different classes of products have a different pattern of effectiveness, suggests that we should recommend the use of chewing materials, and have the owner provide as much variety as the dog will accept. Though not examined in this study, duration of chewing time is likely to be critical (both minutes chewed in any one day, and continued availability over a period of months or years). The beneficial effect of providing access to more than one form of chewing material may result from longer total chewing time each day or from the mixed effect of different materials, or both.

Effectiveness of these products used in this group of dogs is much lower than for frequently and conscientiously applied brushing over long periods in dogs. Recently, a new group of products has been made available that have been shown to significantly reduce accumulation of plaque and/or calculus in dogs. These products include a nutritionally complete dry food manufactured in a form designed to enhance dietary abrasion, a balanced-nutrient chewing product, and a biscuit containing a chemical anti-calculus agent. Whether these products will produce results that are similar to or better than the beneficial effects associated with access to rawhide chews in the group of dogs examined here remains to be documented.

References