A SOFT VERSUS HARD DIET AND ORAL HEALTH IN CAPTIVE TIMBER WOLVES (Canis lupus)

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Summary

Four timber wolves (Canis lupus) were divided into two groups of two wolves each. After an initial oral examination, including the cleaning of all teeth, one group was fed a soft, moist, meat-based canine diet while the second group was fed a hard, dry, extruded dog food. After four months, the teeth were swabbed with an erythrosine dye disclosing agent to stain plaque. Tooth surfaces with the greatest plaque accumulation included the lateral surface of the maxillary fourth premolar, mandibular first molar, and maxillary and mandibular canines. All plaque was supragingival, soft, and no calculus was present. Mean plaque area on susceptible tooth surfaces of wolves fed the hard diet was approximately half that of wolves fed the soft diet. A one-way analysis of variance indicated that this difference was statistically significant (P = 0.03). It thus appears that diet texture is a significant factor in the oral health of wolves.

Introduction

Many types of wild canids are exhibited in zoological gardens and wild animal parks. While the exact nutritional requirements of these species are not known, they have been compared to those of domestic dogs and cats. The most common physical form of canid food used in American zoos is a soft, moist, meat-based diet. Wolves in the wild, along with consuming the viscera and flesh of their prey, will often consume the cartilage, skin, and bone. It is probable that meeting the textural requirements necessary for proper oral hygiene is as important as meeting the nutritional requirements, considering the association of oral pathology with systemic disease. It has been shown that a dry diet for dogs causes less gingival and dental pathology than a soft diet. The purpose of this study was to determine if there is a relationship between diet texture and oral health in timber wolves.

Materials and Methods

Four timber wolves were divided among two groups of two wolves each. One group consisted of two males, 2 1/2-years of age (Group A), and the other of a male, 2 1/2-years of age, and a female, 5-6-years of age (Group B). Group A received 2.27 kg per day of Nebraska Brand Canine Diet, a frozen, meat-based diet which had a soft, moist consistency when thawed before feeding. Group B received 1.65 kg per day of Andersons' Partners Plus Professional Mix, a hard, dry, extruded dog food. The guaranteed analyses and list of ingredients of these diets are shown in Table 1. Initially, all wolves were immobilized with ketamine HCl and xylazine, and a thorough oral examination was performed. Oral health was assessed by determining the amount, consistency and location (supra- or subgingival) of plaque on the gums and teeth, and the gingival sulcus depth. These parameters were considered to be useful indicators of developing periodontal disease. The following teeth were selected as being representative of each area of the mouth: maxillary fourth premolar, mandibular first molar and the maxillary and mandibular canines. All the teeth were cleaned and polished with medium grit, fluoride polisher. This was done in order to begin the experiment with uniformly clean teeth.

After four months, the teeth were re-
examined. This time period was determined to be sufficient for any changes to occur by Dr. David Fagan, consulting oral surgeon for the San Diego Zoological Society (pers. commun.). The teeth were swabbed with an erythrosine dye (FD&C No. 3) disclosing agent to reveal the plaque and calculus.

This was allowed to remain on the teeth for two minutes and was then rinsed off with a water spray. Gingival sulcus depth (Table 2) was determined by inserting the tip of a dental probe between the gum and tooth in anterior, posterior, lateral, and medial quadrants and measuring its depth of penetration. Photographic slides were taken of the lateral surface of the maxillary fourth premolar, and the lateral and medial surfaces of the mandibular first molar, and the frontal and lateral surfaces of the maxillary and mandibular canines. The slides were projected and a tracing made of the tooth surface and the area covered by plaque. A planimeter was used to quantitate total tooth surface and plaque area.

Initially, one-way analysis of variance was used to test for significant differences between the two groups with regard to plaque area on each tooth surface. Because the data were expressed as percentages, they were first transformed to the arc sine square root according to Steel and Torrie.8 Because of missing teeth, the analysis of variance was calculated for unequal sample sizes. Histograms were used to compare graphically the differences in plaque accumulation for each tooth. Finally, a one-way analysis of variance for unequal sample size was performed for those teeth which exhibited plaque accumulation exceeding five percent of the tooth surface.

**Results and Discussion**

The one-way analysis of variance for unequal sample size for all teeth indicated a statistically nonsignificant (P = 0.10) difference between groups. A graphical comparison between groups for each tooth indicated that the medial surface of the mandibular first molar and the frontal surface of the maxillary and mandibular canines accumulated appreciably less plaque than other tooth surfaces (Figure 1). Percent plaque area, averaged for both groups, illustrates this pattern more clearly (Figure 2). Because of this, these teeth were eliminated from a second statistical analysis, which included only tooth surfaces with greater than five percent plaque area. This analysis revealed a statistically significant difference (P = 0.03) between the

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**TABLE 1**

Composition of Experimental Diets

<table>
<thead>
<tr>
<th>Item</th>
<th>Soft</th>
<th>Hard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guaranteed Analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moisture, maximum, %</td>
<td>62.0</td>
<td>12.0</td>
</tr>
<tr>
<td>Crude protein, minimum, %</td>
<td>14.5</td>
<td>21.0</td>
</tr>
<tr>
<td>Crude fat, minimum, %</td>
<td>5.5</td>
<td>10.0</td>
</tr>
<tr>
<td>Crude fiber, maximum, %</td>
<td>1.5</td>
<td>5.0</td>
</tr>
<tr>
<td>Ash, maximum, %</td>
<td>4.5</td>
<td></td>
</tr>
</tbody>
</table>

**Ingredients:**

**Soft** — Horse meat, horse meat by-products, corn, liver, soy grits, meat by-products, steamed bone meal, dried beet pulp, brewers' dried yeast, salt, vitamin and trace mineral supplements.

**Hard** — Corn, meat and bone meal, wheat middlings, animal fat, fish meal, corn gluten meal, soybean meal, wheat, dried whey, dried tomato pomace, salt, soybean oil, brewers' dried yeast, vitamin and trace mineral supplements.

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**TABLE 2**

Mean Gingival Sulcus Depth for All Wolves

<table>
<thead>
<tr>
<th>Tooth</th>
<th>Sulcus Depth, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right:</td>
<td></td>
</tr>
<tr>
<td>Maxillary fourth premolar</td>
<td>2.4</td>
</tr>
<tr>
<td>Mandibular first molar</td>
<td>2.4</td>
</tr>
<tr>
<td>Maxillary canine</td>
<td>3.6</td>
</tr>
<tr>
<td>Mandibular canine</td>
<td>3.6</td>
</tr>
<tr>
<td>Left:</td>
<td></td>
</tr>
<tr>
<td>Maxillary fourth premolar</td>
<td>1.9</td>
</tr>
<tr>
<td>Mandibular first molar</td>
<td>2.7</td>
</tr>
<tr>
<td>Maxillary canine</td>
<td>3.4</td>
</tr>
<tr>
<td>Mandibular canine</td>
<td>3.1</td>
</tr>
</tbody>
</table>

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a. Nebraska Brand Canine Diet, Central Nebraska Packing, Inc., North Platte, Nebraska 69101.
two groups. All the plaque was supragingival, and none had hardened to cause gingival pathology. Thus, statistical comparisons of plaque consistency were not possible. No calculus was present on any of the teeth.

Although the gingival sulcus depth was measured around each tooth before and after the four-month feeding period, the differences in depth were slight and nonsignificant. It is believed that a difference of at least 5 mm is necessary to be of pathological importance. The values in this study ranged from 0-4 mm when differences in initial and final sulcus depths were compared. The final measurements are shown in Table 2; they may represent normal sulcus depth for timber wolves.

Plaque tends to accumulate in those areas at the opening of a salivary duct (maxillary fourth premolar) or where the tongue does not regularly contact the tooth surface. This explains why the front of the canines and the medial mandibular first molar exhibited so little plaque, while the maxillary fourth premolar accumulated so much. The lateral surface of the canines is out of reach of the tongue, so food particles and bacteria accumulate there. It can be seen from these data that wolves fed a hard, dry, extruded diet accumulated significantly less plaque on the maxillary fourth premolar, mandibular first molar and the maxillary and mandibular canines than those fed soft, moist, meat-based diet. This was probably due to the mechanical action of the food which acted as a dietary toothbrush. It has been suggested that the lack of stimulation of the gingivae, as with a soft diet, may lead to stasis of the circulation and a softening of the tissue. This would allow food particles to become trapped within the gingival sulcus and the space to become enlarged. Irritation and inflammation may then develop.

Conclusion
The results of this study indicate that diet texture, which is important in the oral health of domestic canids, is also a significant factor in the oral health of captive wolves. The wolves fed a hard, dry, extruded diet exhibited significantly lower levels of plaque accumulation on susceptible teeth than those fed a soft, moist, meat-based diet. There was little change in the sulcus depth over the study period, and the values obtained may represent normal sulcus depth in timber wolves.

Acknowledgments
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charge of veterinary dentistry at Michigan State University; Gerald Miller, Director of Potter Park Zoo, Lansing, Michigan; and Mary Anne McNamara and Dennis Sweeney, conscientious keepers in charge of the wolves.

Products Mentioned in Text
b. Rompun® — Haver Lockhart Laboratories, Shawnee, Kansas 66201.

References


OSTEOGENIC SARCOMA IN A MANED WOLF (Chrysocyon brachyurus)

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Summary
Over a period of two months, a maned wolf (Chrysocyon brachyurus) developed a space-occupying lesion of the right thigh with subsequent atrophy of the musculature. The animal was euthanized. At necropsy a tumor was found originating in the right thigh, metastasizing to a regional lymph node and to the lung. Histopathology revealed a prominent fibrous component; however, the diagnosis of osteogenic sarcoma was confirmed by ultrastructural analysis.

Introduction
Osteogenic sarcoma, although uncommon in general, is the most frequent malignant neoplasm of the skeleton in non-primate mammals. The species most commonly affected are dogs and cats, with larger breeds developing this neoplasm more often than smaller breeds. The average age group affected is eight years. Common sites for the primary tumor are the long bones of the legs and ribs; however, osteogenic sarcomas in other locations have been described. Metastases are frequently found in regional lymph nodes and in the lungs, as the tumor is usually fast-growing and highly malignant. It may originate from either the endosteum or the periosteum and, depending on the amount of osteoid and bone found, it may be characterized as osteolytic or sclerosing.6, 7, 8

Histopathologically, the tumor presents a