Poor Overall Diet Quality as a Possible Contributor to Calculus Formation

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Purpose: An association between diet and calculus deposits was suggested by animal studies. The objective of the present analysis was to examine whether or not there is an association between overall diet quality, as measured by the healthy eating index, and extent of dental calculus deposits using a subset of the third National Health and Nutrition Examination Survey (NHANES III) data.

Materials and Methods: NHANES III participants 18-years of age or older who had data on dental calculus and diet quality were selected (n = 12405). The healthy eating index (HEI), used as an indicator of overall diet quality, has a minimum score of zero (poorest) and a maximum score of 100 (best) and was divided into three categories, poor (HEI < 51), fair (HEI, between 51 – 80) and good (HEI > 80). Ordinal logistic regression models were used to examine the association between the HEI and the percentage of sites with calculus deposits.

Results: Overall diet quality was found to be significantly associated with calculus deposits controlling for: age, gender, race, education, poverty income ratio, smoking, diabetes, history of vitamin and mineral use, body mass index, time elapsed since last dental visit and gingival bleeding. The adjusted odds ratios for having a greater percentage of sites with calculus were 1.54 (1.19 – 1.98), 1.30 (1.02 – 1.60) and 1.00 (reference) for subjects with poor, fair, and good diet quality respectively.

Conclusion: Poor diet quality is significantly associated with more calculus deposits. Further studies are needed to examine if poor diet quality is a predisposing factor for calculus formation and/or a risk factor for periodontal diseases.

Key words: calculus, diet, healthy eating index, NHANES III

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Dental calculus is a mineralized dental plaque, which forms in individuals with or without regular dental care (Anerud et al, 1991). Calculus deposits contribute to periodontal diseases by retaining bacterial plaque in close contact with the gingiva. Propensity for calculus formation varies among different individuals (Mandel, 1987). Several factors have been reported to be associated with calculus formation such as age, gender, race/ethnicity, diabetes, oral hygiene, and dental care accessibility (Roberts-Harry and Clerehugh, 2000; White, 1997). Salivary environment, bacterial flora and dietary factors may also contribute to calculus formation (Mandel, 1987).

Animal studies have suggested a relationship between the physical nature of the diet and amount of plaque and calculus deposits (Clarke and Cameron, 1998; Egelberg, 1965; Harvey et al, 1996; Gorrel, 1998; Watson, 1994). A study on skeletal material of ancient populations has also suggested a relation between the amount of calculus and type of

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diet (Whittaker et al, 1998). The objective of the present study was to examine whether or not there is a true association between overall diet quality, as measured by the healthy eating index, and extent of calculus deposits in a United States population.

MATERIALS AND METHODS

Data Source

The present study utilized data from the third National Health and Nutrition Examination Survey (NHANES III), a cross-sectional survey conducted by the National Center for Health Statistics from 1988 – 1994 (National Center for Health Statistics, 1994). Participants, 18-years of age or older, who had data on calculus deposits and the healthy eating index were selected (n = 12405), excluding pregnant/nursing women and individuals who were classified under the race/ethnicity category "others".

Outcome

In NHANES III, calculus was recorded as absent, supragingival only, or subgingival (with/without supragingival) on two sites per each tooth of two randomly assigned quadrants, one maxillary and one mandibular. For the purpose of the present study, the percentage of examined sites with calculus for each individual was calculated.

Exposure

The Healthy Eating Index (HEI) is an instrument developed by the United States Department of Agriculture (USDA) to evaluate the overall quality of Americans' diet. In NHANES III, the HEI was estimated based on a 24-hour dietary recall that was administered by a trained interviewer in the mobile examination center (National Center for Health Statistics, 1994). Participants were asked to report their foods and beverages intake for the past 24-hours (except of plain drinking water). The NHANES III dietary recall data was recorded with the assistance of an automated, microcomputer-based dietary interview and coding system.

The HEI has 10 dietary components. Each one of the components has a maximum score of 10 and the sum total of all the components reflects the overall index score (maximum score of 100) (Kennedy et al, 1995). The USDA classified the diet, based on HEI, into one of three categories: "good", "needs improvement" and "poor" if the HEI scores were > 80; 51 to 80; or < 51, respectively (Bowman et al, 1998).

Five of the HEI components measure how well individuals' diet conforms to the Food Guide Pyramid serving recommendations for the five major food groups: grain, vegetable, fruit, milk, and meat groups. Four components measure how well the person's diet conforms to the recommendations for total intake of: total fat, saturated fat, cholesterol and sodium; the last component examines the variety in the diet over a one-day period.

Statistical Analysis

Descriptive statistics and ordinal logistic regression models were utilized for data analyses. For the ordinal logistic regression models, the sample was divided into four groups based on the weighted quartiles of extent of calculus deposits (0 – 10.9, 11 – 28.9, 29 – 54.9, and ≥ 55%). The following variables were controlled for in the final model: age in years, race-ethnicity, gender, poverty index, education attainment, smoking status, history of diabetes, body mass index, vitamin and mineral supplement use, time elapsed since last dental visit, and gingival bleeding.

RESULTS

Description of the Study Population

The proportion of individuals with calculus deposits at ≥ 55% (the 3rd quartile) of examined sites was approximately 34% among older individuals (≥ 60 years) while only 20% of persons aged 18–34 years showed a similar pattern ($p < 0.01$) (Table 1). The proportion of persons with calculus at ≥ 55% of examined sites was greater for males and blacks as compared to females and whites, respectively ($p < 0.01$). Thirty seven per cent of current smokers had calculus at ≥ 55% of examined sites while only 18% of never smokers showed a similar pattern ($p < 0.01$). The proportion of persons with calculus at ≥ 55% of examined sites increased with increasing sites with gingival bleeding and time

Table 1 Characteristics of the study population by extent of calculus deposits

	Sample size	Weighted %	Proportion of individuals with calculus at ≥ 55%† of examined sites*
Age			
Young (18 – 34)	4947	40.81	20.27
Middle-aged (35 – 59)	4690	43.18	25.74
Old (60 – 90)	2768	16.01	33.48
Gender			
Female	6390	50.37	19.43
Male	6015	49.63	30.10
Race/ethnicity			
Whites	4746	81.32	20.75
Blacks	3785	12.46	45.56
Mexican-Americans	3874	6.21	35.27
Smoking			
Never	6391	47.01	17.58
Former	2734	24.05	23.73
Current	3279	28.94	37.26
Education			
< High School	4551	20.31	48.20
= High School	4056	35.37	26.09
> High School	3723	44.32	12.79
Diabetes			
No	11664	96.08	23.97
Yes	727	3.92	44.74
Last dental visit (months)			
0 – 6	3675	37.32	13.85
> 6 – 12	3740	31.51	20.79
> 12 – 24	1544	12.57	33.25
> 24	3369	18.60	47.24
Sites with gingival bleeding (%)			
0	5014	47.93	16.77
< 10	2731	22.61	22.07
10 – 30	3020	20.25	33.31
> 30	1639	9.22	55.09
Diet quality§			
Poor (HEI < 51)	2481	18.10	32.99
Fair (HEI, 51 – 80)	8744	71.28	24.16
Good (HEI > 80)	1180	10.61	15.59

† 55% is the 3rd quartile.
* All the bivariate associations are significant, $P < 0.01$.
§ HEI = healthy eating index.

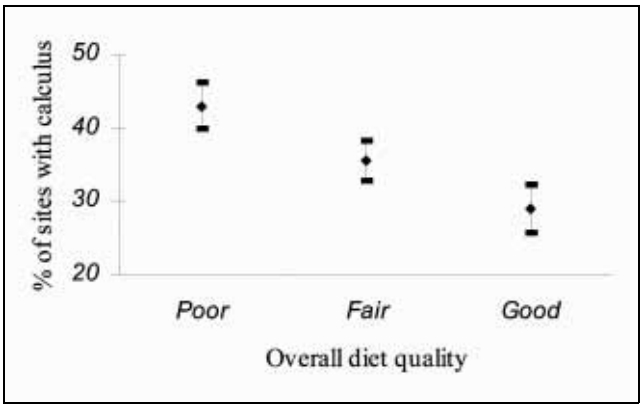

Fig 1 Mean percentage (and 95% confidence interval) of sites with calculus by overall diet quality.

since their last dental visit ($p < 0.01$). Thirty three per cent of persons with poor diet quality had calculus at ≥ 55% of examined sites while only 16% of persons with good diet quality showed a similar pattern ($p < 0.01$). The mean percentage of sites with calculus was higher among persons with poor than those with good diet quality (Fig 1).

Ordinal Logistic Regression Analysis

In the univariate model, poor and fair diet quality was associated with 2 and 1.5 times, respectively, greater odds for having a higher extent for calculus deposits than good diet. After adjusting for potential confounders, the estimate of the association slightly attenuated but it remained moderately strong and significant. Persons with poor and fair diet quality were 54% and 27%, respectively, more likely to have calculus at greater percentage of examined sites than individuals with good diet quality (Table 2). Higher scores for vegetable, fruits, dairy and diet variety were associated with lesser extent of calculus deposits (Table 3). The other healthy eating index components were not found to be significantly associated with the extent of calculus deposits.

Table 2 The estimates of the association between overall diet quality and extent of calculus deposits

	Odds ratio (95% CI)	
	Crude	Adjusted†
Overall diet quality §		
Poor (HEI < 51)	2.22 (1.75 – 2.81)**	1.54 (1.19 – 1.98)**
Fair (HEI, 51 – 80)	1.48 (1.22 – 1.78)**	1.27 (1.02 – 1.60)*
Good (HEI > 80)	1 (Reference)	1 (Reference)
N	12405	11167

* P < 0.05; ** P < 0.01
† Adjusted for age, gender, race, poverty index, education, smoking, diabetes, body mass index, vitamin and mineral use, time since last dental visit and gingival bleeding.
§ HEI = healthy eating index.

DISCUSSION

The results of the present study indicated that individuals with poor and fair diet quality were, respectively, 54% and 27% more likely to have a higher extent of calculus deposits than individuals with good diet quality. Moreover, higher intake of fruits, vegetables and dairy as well as more variety in the diet were associated with a lower extent of calculus deposits. These findings are consistent with the results from animal studies that reported a relation between nature of diet and amount of calculus deposits (Clarke and Cameron, 1998; Harvey et al, 1996; Watson, 1994).

Since bacterial plaque is a prerequisite for calculus development, diet may contribute to calculus formation by altering dental plaque formation and/or composition. It has been suggested that diet influences development and survival of plaque biofilm, by providing direct nutrient source or by altering their surrounding environment (Bowden and Li, 1997). Moreover, natural texture diet (i.e. fruits and vegetables) has been suggested to reduce plaque accumulation, while softer diet may promote plaque accumulation (Newman, 1974). Diet may also affect calculus formation by influencing plaque calcification through changing the pH and mineral content of the saliva.

The role of dental calculus in the initiation and progression of periodontal disease is generally attributed to the overlying dental plaque. In addition, calculus has the potential for retaining toxic substances through its rough porous surfaces. Wheth-

er calculus with its overlying plaque is more harmful than plaque alone is not clear (Mandel, 1987). Dental calculus, however, would bring the bacterial deposits in close contact with the periodontal tissues and would also interfere with patients' mechanical plaque removal. Therefore, prevention of calculus formation and/or professional removal by scaling and root planing is required for maintaining a healthy periodontium.

In conclusion, the results of this study that utilized a large US national survey data support an association between overall diet quality and extent of calculus deposit. The reported relation is less likely to be explained by a particular behavioral pattern since the association remained moderately strong and significant after adjusting for several confounders including gingival bleeding and time since last dental visit. However, the nature of the association cannot be determined from our analysis, due to the cross-sectional study design. If the association is found to be causal, poor overall diet quality may explain part of the individuals' differences in propensity for calculus formation. Individuals with poor eating habit may need to have more frequent dental visit than those with good eating habit. In addition, dental health professionals need to encourage healthy dietary intake to improve general health and possibly oral health as well.

Table 3 The estimates of the association between healthy eating index components and extent of calculus deposits (n = 11167)

	Adjusted Odds ratios (95% CI) †
Grain (more serving)	0.97 (0.859 – 1.102)
Fruit (more serving)	0.80 (0.723 – 0.879)**
Vegetable (more serving)	0.87 (0.806 – 0.938)**
Dairy (more serving)	0.90 (0.827 – 0.988)*
Meat (more serving)	0.98 (0.882 – 1.085)
Fat (less in diet)	1.04 (0.956 – 1.141)
Saturated Fat (less in diet)	1.00 (0.921 – 1.087)
Cholesterol (less in diet)	1.04 (0.933 – 1.150)
Sodium (less in diet)	1.03 (0.958 – 1.114)
Variety (more variety)	0.78 (0.704 – 0.863)**

* $P < 0.05$; ** $P < 0.01$.
† The odds ratio for a 5-point increase in component scores; adjusted for age, gender, race, poverty index, education, smoking, diabetes, body mass index, vitamin and mineral use, time since last dental visit and gingival bleeding.

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