

Received: 2011.09.26
Accepted: 2011.11.03
Published: 2011.11.25

Assessment of the influence of vegetarian diet on the occurrence of erosive and abrasive cavities in hard tooth tissues

Ocena wpływu diety wegetariańskiej na występowanie ubytków erozyjnych i abrazyjnych twardych tkanek zębów

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Summary

Introduction:	The aim of the study was to determine the potential relation between vegetarian diet and tooth erosion and abrasion.
Material/Methods:	The examination included 46 vegetarians and the same number in the control group. Clinical research was carried out in order to detect the presence of abrasive and erosive changes and the level of hygiene in oral cavities. The questionnaire survey concerned dietary and hygienic habits. Statistical analysis of the data was conducted with Chi-square test and Mann-Whitney U test. The relations between following a vegetarian diet and the occurrence of non-cariou cavities was tested with models of logistic regression.
Results:	Tooth erosion was present among 39.1% of vegetarians and 23.9% of controls, while abrasion appeared among 26.1% and 10.9%, respectively, and the differences were statistically insignificant. The distribution of the changes was similar in both groups. Among vegetarians, significantly more frequent consumption of sour products (predominantly raw vegetables and fruit and tomatoes) was observed. The level of oral hygiene and hygienic habits were similar in both groups. The analysis of statistical regression did not reveal any relations between following a vegetarian diet and the occurrence of tooth erosion and abrasion.
Discussion:	The results did not reveal any direct influence of vegetarian diet on the occurrence of erosive and abrasive changes. However, in the vegetarian group, more frequent consumption of some sour products and more commonly used horizontal brushing method were observed, with a slightly higher occurrence of non-cariou cavities. Further research is required to obtain unambiguous conclusions.
Key words:	vegetarian diet • tooth erosion • tooth abrasion

Streszczenie

Cel pracy:	Celem pracy było określenie ewentualnych zależności między stosowaniem diety wegetariańskiej a występowaniem erozji i abrazyj zębów.
Materiał/Metody:	Zbadano 46 lakto- i lakto-owo-wegetarian i tyle samo osób z grupy kontrolnej. Przeprowadzono badanie kliniczne pod kątem obecności zmian abrazyjnych i erozyjnych oraz poziomu higieny jamy ustnej. Badanie ankietowe dotyczyło nawyków dietetycznych i higienicznych. Analizę

statystyczną uzyskanych danych przeprowadzono za pomocą testu Chi-kwadrat i U Manna-Whitneya. Zależności między stosowaniem diety vegetariańskiej a powstawaniem ubytków niepróchnicowych badano za pomocą modeli regresji logistycznej.

Wyniki: Erozję zębów stwierdzono u 39,1% vegetarian i 23,9% badanych z grupy kontrolnej, abrazję odpowiednio u 26,1 i 10,9%, różnice były nieistotne statystycznie. Rozmieszczenie zmian było podobne w obu grupach. Zaobserwowano istotnie częstsze spożycie niektórych kwaśnych produktów wśród vegetarian (ogólnie surowych warzyw i owoców oraz pomidorów). Poziom higieny jamy ustnej oraz nawyki higieniczne badanych nie różniły się znamienne w obu grupach. Analiza regresji logistycznej nie wykazała zależności między stosowaniem diety vegetariańskiej a występowaniem erozji i abrazji zębów.

Wnioski: Uzyskane wyniki nie wykazały bezpośredniego wpływu diety vegetariańskiej na tworzenie się zmian erozyjnych i abrazyjnych. Zaobserwowano jednak częstszą konsumpcję niektórych kwaśnych produktów oraz bardziej rozpowszechniony nawyk szczotkowania zębów techniką poziomą przy jednocześnie nieco wyższej liczbie ubytków niepróchnicowych w grupie vegetarian. Dlatego potrzebne są dalsze badania mogące jednoznacznie wyjaśnić to zagadnienie.

Słowa kluczowe: dieta vegetariańska • erozja zębów • abrazja zębów

Full-text PDF: <http://www.phmd.pl/fulltxt.php?ICID=967066>

Word count: 2139

Tables: 4

Figures: 2

References: 22

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INTRODUCTION

The principle of a vegetarian diet is the exclusion of meat. There are numerous variations of it, the most radical of which is veganism, which allows only plant foods. Lacto vegetarianism allows plant foods with dairy products, and lacto-ovo vegetarianism also adds eggs to the diet. So far there have been few publications dealing with the influence of the above ways of feeding on the condition of the oral cavity. The risk of non-carious lesions such as abrasion and erosion is particularly looked on [11,20].

The pathology of the erosion process relies on surface loss of hard tooth tissues caused by chemical factors, mainly acids. The most common source of acids is food. Products especially strengthening erosion include citrus fruit, berries, fruit juice, fizzy drinks, wine, marinades and soluble tablets with vitamin C content [6,8,13,16].

Unlike erosion, the process of abrasion is not caused by chemical factors, but mechanical ones having an impact on hard tooth tissues. The abrasive lesions appear only in the buccal surfaces. There are several causes of abrasion. Frequent cleaning of teeth with excessive force and use of an improper horizontal brushing method as well as the application of highly abrasive toothpaste can have a significant influence on the occurrence of this process [13,15,17]. It was observed that enamel subjected to acids is more susceptible to mechanical damage, which leads to faster destruction of hard tooth tissues [5,7].

Due to the fact that few publications raise the question of the influence of vegetarian diet on the occurrence of

abrasive and erosive cavities, the aim of this paper was to investigate the matter.

MATERIALS AND METHODS

The research was carried out in the Department of Conservative Dentistry and Pedodontics in Wrocław, Poland.

All subjects were informed about the aim and manner of the research and gave their written consent. They were people in generally good health. The test group (I) included 46 persons aged 17-51, 14 men and 32 women, all on a meat-free diet for a period of 1-18 years (9 on average). They were all lacto vegetarians, 76.1% of them lacto-ovo vegetarians. The subjects were invited to participate in the experiment through advertisements on the Internet and in magazines for vegetarians. With a few exceptions the persons inhabited Wrocław and neighboring villages. The control group (II) consisted of 46 persons following a traditional diet and selected to match the sex, age and education of the vegetarian group. The average age in both groups was 30. The clinical research included the inspection of teeth for erosion and abrasion as well as examination of the level of hygiene in oral cavities with the Oral Hygiene Index (OHI) according to Green Vermillion (1960), which is the total of the debris index (DI) and the calculus index (CI).

Subjects from both groups filled in questionnaires on dietary and hygienic habits. The questions concerned the frequency of consumption of particular products, mainly sour ones, such as fruit juice, raw fruit and vegetables, fizzy drinks, dishes containing vinegar and fruit teas. Additionally, each

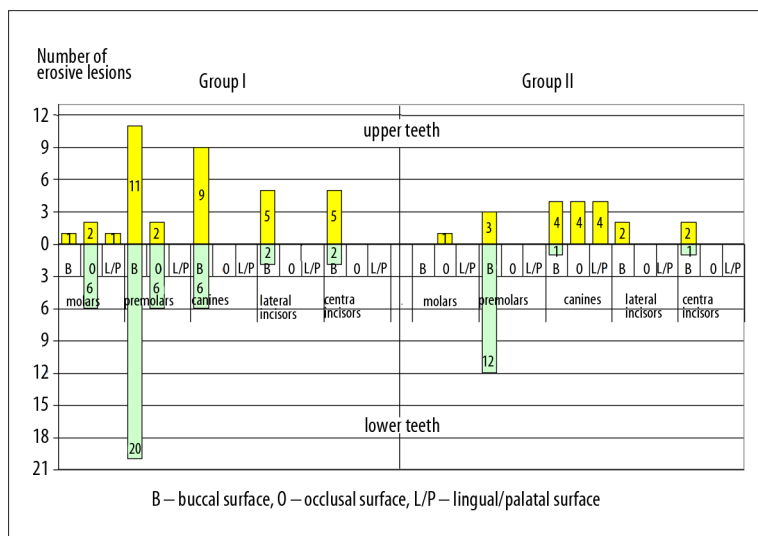


Fig. 1. The distribution of erosive lesions on teeth surfaces

person wrote a detailed description of eaten products from seven days before, giving information on the preparation, composition and time of consumption.

The questions also concerned the frequency and times of brushing teeth, brushing techniques, toothbrush hardness and the application of fluoride toothpastes, toothpicks and dental flosses.

The statistical analysis of the data was done with the Chi-squared test and Mann-Whitney U test. The influence of vegetarian diet on the occurrence of abrasive and erosive cavities was tested with models of logistic regression, in which odds ratios (OR) were set for particular factors. Model 1 – the relation between occurrence of erosion and the composition of subjects’ diet: vegetarian diet: 0 – no; 1 – yes; length of diet: years; frequency of consumption of particular products: 0 – a few times monthly or more rarely; 1 – a few times weekly; 2 – a few times daily. Model 2 – the relation between the occurrence of abrasion and subjects’ hygienic habits and type of diet: vegetarian diet: 0 – no; 1 – yes; length of diet: years; frequency of teeth brushing: 0 – up to once daily; 1 – twice or more daily; time of teeth brushing: 0 – regardless of meals; 1 – before breakfast and after supper; 2 – after meals; technique of tooth brushing: 0 – horizontal; 1 – other; type of toothbrush: 0 – hard; 1 – medium hard or soft; other hygienic means used (dental flosses, toothpicks): 0 – no; 1 – yes.

The procedure of elimination of model variables on the basis of the Akaike information criterion (AIC) was applied. All hypotheses were verified at the significance level $p < 0.05$.

RESULTS

The survey data revealed that 82.6% of subjects from group I and 60.9% from group II consumed raw fruit at least once a day, which constituted a statistically significant difference ($p < 0.05$). Raw vegetables were consumed at least once a day by 37% of vegetarians and 13% of people from the control group, which was also a statistically significant difference ($p < 0.001$). A detailed analysis of particular kinds of fruit revealed more frequent consumption

of apples, grapes, tomatoes, oranges, tangerines and grapefruits in group I; however, a statistically significant difference was found only in the case of tomatoes ($p < 0.05$). The data also revealed that 30.4% of subjects from group I consumed fruit juice once a day or more often (19.5% in the control group). A similar tendency was observed in the case of fruit teas: in group I 32.6% of persons drank them at least once a day, in group II 17.4%. Another thing observed was higher consumption of dishes containing vinegar in the vegetarian group. None of the above, however, proved to be statistically significant. What turned out to be so ($p < 0.05$) was the consumption of fizzy drinks in group II: 89.2% claimed to drink them a few times a month (in group I – 63%).

All subjects used fluoride toothpaste. The vast majority of them (87% in group I and 89.1% in group II) brushed their teeth at least twice a day. The improper habit of brushing teeth before breakfast was observed. Such behavior characterized every second vegetarian and 39.1% of persons in the control group. Also among vegetarians the improper horizontal brushing method was observed more often (61%, 41% in the control group). Another finding was that subjects having a meat-free diet used additional hygienic means such as dental flosses and toothpicks. None of the above, however, was statistically significant.

Erosive changes were observed among 39.1% of vegetarians and 23.9% of subjects in the control group and it was not statistically significant. The distribution of the changes on particular teeth surfaces and in teeth anatomical groups was similar in groups I and II (fig. 1).

Abrasive changes occurred among 26.1% in group I and 10.9% in group II and their distribution was similar (fig. 2). Abrasive and erosive changes appeared among 4 subjects in group I (8.7%) and 2 persons in group II (4.4%), which was statistically insignificant.

The level of hygiene of oral cavities was comparable in both groups (group I: DI=0.70, CI=0.30, OHI=1.00; group II: DI=0.80, CI=0.34, OHI=1.14). Low average values of OHI and components (DI, CI) suggested a satisfactory level of hygiene.

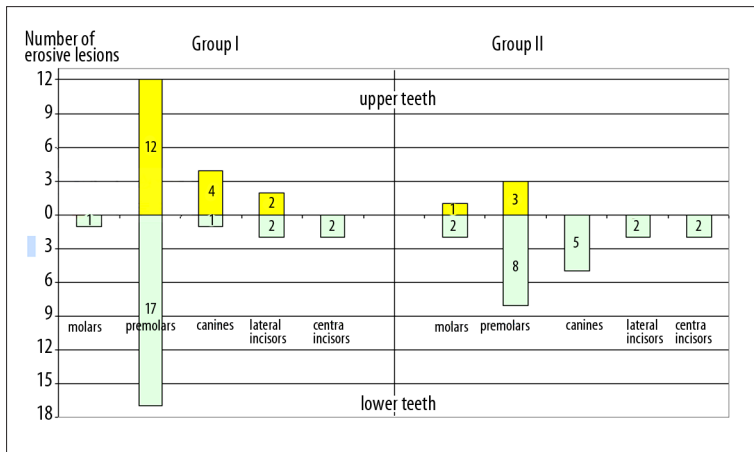


Fig. 2. The distribution of abrasive lesions in particular anatomical teeth groups

Table 1. Model 1: analysis of logistic regression of the relation between occurrence of erosion and the composition of subjects' diet

	Odds ratio	Lower	Upper	p
Vegetarian diet	1.03	0.17	6.32	0.98
Length of diet	1.04	0.89	1.22	0.58
Fruit in total	1.27	0.32	5.15	0.73
Apples	1.40	0.57	3.45	0.47
Tomatoes	1.08	0.49	2.40	0.85
Oranges	1.64	0.35	7.60	0.53
Tangerines	1.11	0.24	5.07	0.89
Lemons	1.26	0.61	2.60	0.54
Grapefruits	0.32	0.07	1.58	0.16
Carrots	0.35	0.14	0.90	0.03
Vegetable salads	1.14	0.48	2.73	0.77
Fizzy drinks	1.13	0.44	2.95	0.80
Fruit juices	1.59	0.78	3.25	0.20
Vinegar	1.18	0.35	4.01	0.79
Fruit teas	2.03	1.02	4.01	0.04
Soluble tablets containing vit. C	0.36	0.09	1.48	0.16

Table 1 presents the results of analysis of tooth erosion risk factors. In the model there was no relation between the application and length of vegetarian diet and consumption of sour products (except fruit teas) and the occurrence of erosion. No co-variables were observed in model 2 analyzing abrasion risk factors (tab. 2). Model 3 contains summary dietary and hygienic factors that may influence the occurrence of cavities of non-carious origin (erosion and/or abrasion) (tab. 3). Variables worth mentioning include application of additional means of hygiene (OR=3.50), orange consumption (OR=3.09), and intake of fruit teas (OR=2.98). In the final model obtained through stepwise selection of variables only dietary factors were

Table 2. Model 2: analysis of logistic regression of the relation between the occurrence of abrasion and subjects' hygienic habits and type of diet

	Odds ratio	Lower	Upper	p
Vegetarian diet	0.85	0.12	5.95	0.87
Length of diet	1.10	0.93	1.30	0.28
Frequency of teeth brushing	0.68	0.13	3.61	0.65
Time of teeth brushing	0.57	0.17	1.89	0.36
Technique of tooth brushing	0.71	0.22	2.27	0.57
Type of toothbrush	0.44	0.04	5.47	0.53
Other hygienic means used	0.60	0.18	2.02	0.41

left (consumption of apples, oranges, grapefruits, carrots, fruit teas and soluble tablets containing vitamin C) (tab. 4).

DISCUSSION

The data obtained indicate slightly more frequent occurrence of tooth erosion and abrasion among vegetarians (higher number in group I, yet not statistically significant). Linkosalo and Markanen [11] observed erosive changes among 76.9% of examined vegetarians in Finland and no such changes among their control group. The changes appeared most often on occlusal surfaces. Glossal surfaces, however, were as frequently affected by the process as cheek surfaces. Our own research indicated that most erosive changes appeared on labial surfaces.

Sherfudhin and partners [20] having examined a group of 30 vegetarians from India observed more frequent (yet statistically insignificant) occurrence of non-carious neck cavities of abrasive and erosive nature in comparison to the control group (30% and 12% respectively).

Al-Dlaigan and partners obtained different results. During research carried out among British 14-year-olds they demonstrated the occurrence of small and medium erosive changes among both vegetarians (constituting 10% of all subjects) and the remaining children and did not note any statistically significant differences in the frequency of such changes [1].

Table 3. Model 3: analysis of logistic regression of the relation between the occurrence of cavities of non-carious origin (erosion and abrasion) and type of preferred diet and subjects' hygienic habits

	Odds ratio	Lower	Upper	p
Vegetarian diet	0.59	0.07	4.90	0.63
Length of diet	1.12	0.94	1.34	0.21
Frequency of teeth brushing	1.03	0.16	6.84	0.97
Time of teeth brushing	0.69	0.19	2.53	0.57
Technique of tooth brushing	0.88	0.25	3.17	0.85
Type of toothbrush	0.11	0.01	1.72	0.12
Other hygienic means used	3.50	0.86	1.22	0.08
Fruit in total	1.23	0.28	5.51	0.78
Apples	2.40	0.89	6.45	0.08
Tomatoes	0.67	0.29	1.53	0.34
Oranges	3.09	0.55	17.33	0.20
Tangerines	0.44	0.08	2.32	0.33
Lemons	1.02	0.46	2.25	0.96
Grapefruits	0.49	0.11	2.09	0.33
Carrots	0.49	0.18	1.29	0.15
Vegetable salads	0.80	0.31	2.04	0.64
Fizzy drinks	1.78	0.66	4.83	0.26
Fruit juices	1.32	0.64	2.70	0.45
Vinegar	0.57	0.13	2.42	0.44
Fruit teas	2.98	1.40	6.36	0.00
Soluble tablets containing vit. C	0.37	0.11	1.29	0.12

Analyzing data from our research, it must be said that quite a high percentage of subjects with erosive changes was also observed in the control group (23.9%). The occurrence of erosive cavities among subjects of different ages has been observed by many authors from different countries. Wiegand and partners found the presence of erosion among 32% of kindergarten children in Germany [22]. According to El-Aidi and partners, the frequency of erosion among Dutch youth varies from 30.4% among 11-year-olds to 44.2% among 15-year-olds.[3]. El Karim and partners diagnosed such changes among as many as 66.9% of subjects aged 12–14 living in Sudan [4]. Such frequent occurrence of erosion probably stems from the fact that more frequent consumption of fruit, vegetables, fruit juices and fizzy drinks as a result of the change in dietary habits is a noticeable tendency in many countries in which various feeding models are preferred and it does not concern solely vegetarians.

Our research indicates that subjects on a meat-free diet more often consumed raw fruit and vegetables. The information contained in most publications is similar. Linkosalo

Table 4. Final model received through stepwise selection of variables

	Odds ratio	Lower	Upper	p
Apples	1.69	0.83	3.43	0.15
Oranges	2.37	0.84	6.65	0.10
Grapefruits	0.31	0.07	1.38	0.12
Carrots	0.41	0.17	0.95	0.04
Fruit teas	2.06	1.13	3.76	0.02
Soluble tablets containing vit. C	0.45	0.13	1.56	0.21

and Markkanen's research indicates that sour products were consumed daily by 30% of vegetarians and merely 8% in the control group [11]. Johansson and Ravalid observed significantly more frequent consumption of raw fruit by vegetarians in Sweden [9] and Al-Dlaigan and partners showed a similar tendency among youth living in the UK [1]. However, other authors did not observe any significant differences in the frequency of consumption of the products in question between vegetarians and subjects following a traditional diet [10,20].

Our research also indicates a slightly higher frequency of abrasion among subjects on a meat-free diet: 26.1% (10.9% in the control group). The above-mentioned research by Sherfudhin and partners indicates a higher (yet not statistically significant) number of abrasive changes among vegetarians [20].

Similarly to erosion, frequent abrasive changes can also be observed not only among vegetarians. Lussi and partners discovered such cavities among 19.1% of persons aged 26–30 and 47.2% aged 46–50 living in Switzerland [14]. This may be connected with greater care for hygiene in the oral cavity and an incompetent manner of cleaning teeth with highly abrasive toothpaste.

This thesis may be proven by the data from this paper which indicate a high level of hygiene in both the study and the control groups. No statistically significant changes in terms of hygiene maintenance were observed in the groups, which coincides with other authors' reports [12,20].

The present research did not indicate any direct relations between vegetarian diet and the occurrence of tooth erosion and abrasion. In the models of logistic regression, neither being a vegetarian nor the length of using such diet constituted a risk factor for the occurrence of abrasive and erosive cavities. No statistical significance was found in the case of numerous factors recognized as substantial in the processes of abrasion and erosion.

The analysis of the results must take into consideration the fact that etiology of cavities of non-carious origin is very complex and still not completely explained. The chemical or mechanical factors alone need not cause the destruction of hard tooth tissues. Other factors such as saliva properties, level of mineralisation of hard tooth tissues, the influence of soft tissues surrounding the tooth and occlusive

conditions may have a great impact [2,8,18,19,21]. Thus, statistical models taking into account only certain potential etiological factors are not always able to determine the real influence on the occurrence of such defects.

Certain tendencies to consume a bigger amount of sour products and the application of an improper horizontal

brushing method that have been observed in this paper may also lead to the occurrence of abrasive and erosive changes. As a higher frequency of such changes has been found among vegetarians, it seems that this group may be more susceptible to such defects than subjects following a traditional diet. However, there has not been enough research so far to prove this hypothesis.

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The authors have no potential conflicts of interest to declare.