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Article *in* Australian orthodontic journal · May 2011

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Comparison of dietary intake between fixed orthodontic patients and control subjects

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Background: Adolescence is a period of rapid physiological and psychological development which is associated with an increased demand in nutritional requirements. Orthodontic therapy is also commonly initiated during this phase of life and nutritional intake may also change during treatment.
Aims: To compare the nutrient intakes of adolescents wearing fixed orthodontic appliances and a control group matched for age and gender.
Method: A total of 180 patients aged between 15 and 17 years participated in this study (90 in the study group and 90 controls). Demographic data were collected by questionnaire and dietary intake was assessed using a 24-hour memory recall and was analysed using Dietplan6 software (Forestfield Software Ltd, UK). Comparisons between groups were assessed by the Independent sample *t*-test and the SPSS was used for statistical analysis.
Results: Orthodontic patients consumed a similar number of total calories, protein and carbohydrate ($p > 0.05$); however, they had a greater intake of total fat, saturated fat, monosaturated fat, polysaturated fat, linolenic fat, linoleic fat and cholesterol and significantly lower intake of fibre, chromium and beta-carotene ($p < 0.05$) compared with the Control group. The intake of other macro- and micro-nutrients did not differ significantly between groups.
Conclusions: Adolescents receiving orthodontic treatment have an altered dietary intake that can be harmful to their health. As adolescents are at a critical stage of development and dietary intake is of particular importance, it is recommended that targeted nutritional guidance is provided to patients during orthodontic treatment.
(Aust Orthod J 2011; 17–22)

Received for publication: August 2010
Accepted: December 2010

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Introduction

Adolescence is a period of profound physiological and psychosocial change that is also associated with altered nutritional needs.[1] Adolescents are vulnerable because of increased dietary requirements during this period when changes in lifestyle and food habits greatly affect nutrient intake.[2] In addition, adolescents are typically involved in orthodontic treatment, during which modified nutritional needs are required but poor dietary behaviour is likely.[3] It is accepted that orthodontic treatment causes pressure sensitivity to the teeth which leads to pain, discomfort and functional limitations.[4–7] The mastication of hard foods is therefore difficult for patients and there is a tendency for soft foods to be eaten. The avoidance of hard-to-chew natural foods usually involves the elimination of solid foods such as raw vegetables and fresh fruit,[8–11] stringy foods such as meat[12–14] and dry foods such as bread or bagels[12,13] from the diet.

A previous examination of patient nutrient intake before and after orthodontic adjustment reported a decrease in the intake of copper and manganese and

a possible detrimental effect on the rate of tooth movement.[15] Orthodontists recommend that patients avoid hard foods that may cause appliance damage which, in turn, may affect nutrient intake. Moreover, occlusal changes during treatment may also impair mastication and patients may cope by altering their diet or by swallowing coarse particles leading to digestive disorders. In both circumstances, impaired dietary intake may increase nutrition-induced disease risks.[16]

In 1981, Nanda and Hickory[3] stated that, although orthodontists rarely see manifestations of nutritional deficiencies in their patients, suboptimal levels of certain nutrients are common and may affect the biologic response of tissues. It has been reported that between 17 and 72 per cent of orthodontic patients may have suboptimal levels of ascorbic acid and a deficiency may affect the connective tissue of the periodontal ligament and the formation of osteoid.[17,18] In addition, nutritional stress to the periodontium, coupled with the irritation of orthodontic bands and brackets, may cause an altered gingival response.[3]

There are few reports that have examined the effects of orthodontic treatment on a patient's diet. Therefore, the aim of the present study was to compare the dietary intake of individuals receiving orthodontic treatment with healthy teenagers who were gender and age matched.

Material and methods

Subjects

Two groups totalling 180 adolescents aged 15 to 17 years participated in the study. Each group contained 90 individuals; 31 boys and 59 girls in the Orthodontic treatment group and 34 boys and 56 girls in the Control group. The sample was derived from teenagers seeking orthodontic treatment in the Mashhad Faculty of Dentistry, Mashhad, Iran. The socioeconomic status of the two groups was comparable and comprehensive orthodontic treatment of the test group had been implemented for at least six months prior to the nutritional assessment. Orthognathic surgery patients were excluded from the study.

The Control group comprised individuals between 15 to 17 years of age, who were eligible but yet to receive orthodontic treatment. Patients in the control group who had active dental disease were also excluded from the study.

Table I. Demographic data of the orthodontic patients and the control subjects.

	Orthodontic group	Control group	p^*
	N = 90	N = 90	
Age (years)	15.95 ± 1.40	15.91 ± 1.38	0.348
Weight (kg)	53.85 ± 8.93	54.60 ± 9.20	0.766
Height (cm)	162.80 ± 7.55	159.85 ± 7.53	0.178
BMI (kg/m^2)	20.55 ± 2.56	21.58 ± 2.24	0.435

Values expressed as Mean ± SD
* Student's *t*-test
BMI, body mass index

All patients provided informed consent and participation in the study was approved by the Ethics Committee of the Research Council of Mashhad University of Medical Sciences.

Anthropometric assessment

Measurements of the height (in centimetres) and weight (in grams) were performed in all subjects. Height was measured to the nearest millimetre with a wall-mounted Harpenden stadiometer (Holtain Ltd, Croswell, Crymych, UK) and weight was measured with electronic scales (Model 1609N; Tanita Corporation, Tokyo, Japan) to the nearest 0.1 kg. Body mass index (BMI) in kg/m^2 was also calculated.

Dietary assessment

A questionnaire was designed to collect demographic data (age, gender) as well as information regarding the '24-hour dietary recall'. A trained interviewer asked subjects in a face-to-face interview, to recall and describe every item of food and drink consumed over the previous 24 hours.[2] The recording of foods and beverages for individuals who were ill at the scheduled time for dietary assessment were postponed to the next appointment. Individual nutritional intakes were assessed with the use of Dietplan[6] software (Forestfield Software Ltd., UK) which can analyse and identify macro and micro nutrient intake.

Statistical analysis

The results obtained from the Nutrition Analysis Software were entered into the SPSS software for statistical analysis. Comparisons of macro-and micro-

Table II. Dietary intake of calories and macronutrients of orthodontic patients and control subjects.

Calories/Macronutrients	Mean intake		*p**
	Orthodontic group	Control group	
	N = 90	N = 90	
Food energy (kcal)	1703.66 ± 608.92	1634.68 ± 738.13	0.492
Fat			
Total fat (g)	69.88 ± 35.33	56.54 ± 34.93	0.011
Cholesterol (mg)	232.26 ± 186.74	166.05 ±111.09	0.004
Saturated fat (g)	23.39 ± 14.03	17.75 ± 9.70	0.002
Monounsaturated (g)	20.77 ± 11.40	17.01 ± 13.1	0.040
Polyunsaturated (g)	20.31 ± 13.81	16.16 ± 13.79	0.043
Oleic fat (g)	12.86 ± 9.79	10.88 ± 12.11	0.227
Linoleic fat (g)	18.11 ± 13.68	14.11 ± 12.29	0.039
Linolenic fat (g)	0.91 ± 1.26	0.58 ± 0.90	0.045
EPA-Omega 3 (g)	0.003 ± 0.017	0.0001 ± 0.001	0.068
DHA-Omega 3 (g)	0.02 ± 0.086	0.008 ± 0.01	0.222
Carbohydrates			
Total carbohydrates (g)	212.08 ± 85.27	226.32 ± 112.57	0.337
Sugar (g)	63.58 ± 39.81	74.62 ± 49.65	0.100
Glucose (g)	9.04 ± 9.67	20.98 ± 105.85	0.288
Galactose (g)	3.30 ± 3.00	3.71 ± 5.56	0.538
Fibre			
Dietary fibre (g)	9.47 ± 7.04	12.70 ± 9.37	0.007
Soluble fibre (g)	0.20 ± 0.25	0.39 ± 0.58	0.003
Insoluble fibre (g)	1.46 ± 2.03	2.57 ± 3.47	0.009
Crude fibre (g)	4.22 ± 3.04	4.92 ± 4.37	0.215
Protein (g)	69.29 ± 29.78	66.57 ± 34.19	0.568

Values expressed as Mean ± SD
* Student's *t*-test, significant values in bold
EPA, eicosapentaenoic acid
DHA, docosahexaenoic acid

nutrient dietary intake between the Orthodontic group and the Control group were assessed by the Independent sample t-test with a Bonferroni correction for multiple measurements. A p value < 0.05 was considered significant.

Results

The descriptive statistics including the means and standard deviations of demographic data (in both groups) are presented in Table I. The mean values of age, height, weight and BMI of the Orthodontic group were not significantly different from the Control group (p > 0.05).

Comparison of the macronutrient intakes

The orthodontic patients had a markedly greater intake of total fat (p = 0.011), cholesterol (p = 0.004), saturated fat (p = 0.002), monosaturated fat (p = 0.04), polysaturated fat (p = 0.043), linoleic fat (p = 0.039), linolenic fat (p = 0.045) and significantly lower intake of fibre (p = 003) in comparison with the Control group, but consumed a similar number of calories, protein and carbohydrate (Table II).

Comparison of the micronutrient intakes

The mean intakes of chromium (p = 0.024) and beta-carotene (p < 0.001) in the Control group were

Table III. Dietary intake of vitamins and trace elements (Micronutrients) of orthodontic patients and control subject

Vitamins, minerals and trace elements	Mean intake		*p**
	Orthodontic group	Control group	
	N = 90	N = 90	
Sodium (mg)	2533.49 ± 1287.97	2267.21 ± 1677.78	0.231
Potassium (mg)	2513.76 ± 1089.15	2860.09 ± 1682.35	0.099
Iron (mg)	9.47 ± 4.59	9.11 ± 5.92	0.648
Calcium (mg)	1007.68 ± 583.72	1033.16 ± 891.85	0.820
Magnesium (mg)	253.50 ± 122.54	258.14 ± 136.03	0.809
Phosphorus (mg)	1231.85 ± 587.50	1237.29 ± 891.76	0.961
Zinc (mg)	8.78 ± 4.08	8.39 ± 5.00	0.569
Copper (mg)	1.13 ± 0.87	1.14 ± 1.15	0.935
Manganese (mg)	2.96 ± 2.39	3.05 ± 1.75	0.765
Chromium (mg)	.016 ± .018	.026 ± .034	0.024
Vitamin A (Ug)	834.87 ± 1055.91	767.40 ± 704.67	0.612
Beta-Carotene (Ug)	72.10 ± 114.70	278.34 ± 528.57	<0.001
Vitamin E (mg)	10.74 ± 11.33	9.92 ± 6.06	0.541
Thiamin(B1) (mg)	1.27 ± 0.56	1.42 ± 0.85	0.176
Riboflavin(B2) (mg)	1.92 ± 1.14	2.01 ± 1.62	0.682
Niacin (B3) (mg)	15.60 ± 9.77	16.92 ± 9.99	0.369
Pyridoxine (B6) (mg)	1.13 ± 0.57	1.40 ± 1.19	0.052
Folic Acid (Ug)	228.13 ± 129.56	226.70 ± 152.27	0.946
Cobalamin(B12) (Ug)	2.78 ± 1.84	2.30 ± 1.82	0.076
Pantothenic Acid (mg)	3.00 ± 1.62	3.06 ± 2.02	0.838
Vitamin C (mg)	78.32 ± 76.39	100.00 ± 84.18	0.070
Vitamin D (Ug)	1.61 ± 1.83	1.18 ± 1.86	0.119
Vitamin K (mg)	68.64 ± 93.94	68.06 ± 92.21	0.966

Values expressed as Mean ± SD

* Student's *t*-test, significant values in bold

significantly higher compared with the Orthodontic group. The nutrition analysis indicated that there were no significant differences between two groups in the intake of other vitamins and trace elements (Table III).

Discussion

The most important finding of this study was the significantly higher intake of fat and lower intake of fibre in the Orthodontic group compared with the Control group. In addition, the intake of chromium and beta-carotene was lower in the Orthodontic group relative to the Control group. Furthermore, the intake of saturated, monosaturated and polysaturated fat and cholesterol was significantly higher in the Orthodontic group.

Consistent with the present findings, Riordan[15] showed that the intake of fat was higher after orthodontic adjustment. However, the differences that have been previously reported did not reach statistical significance. This may be possibly related to the small sample size (10 participants; 3 boys, 7 girls between the ages of 12 and 16 years) and the short time of intervention in the earlier study.

Saturated fatty acids are reported to be a risk factor for atherosclerosis and increased cholesterol and saturated fatty acid intake increases the risk of cardiovascular disease.[19–21] In addition, it is known that a diet high in fat is associated with obesity, which in turn increases the risk of hypertension,[22] cardiovascular disease and noninsulin-dependent diabetes.[23,24] Further concern was noted in the dietary intake of

fibre which was lower in orthodontic patients compared with control subjects. Fibre has been shown to have beneficial physiological functions in the gastrointestinal tract and in reducing the risk of coronary artery disease and cancer.[2] Fibre binds bile acids and increases the excretion of bile acid-derived cholesterol. It also prevents dietary fat and cholesterol absorption by the binding of bile acids to fat and lipids.[2]

Chromium is involved in insulin secretion and also supports normal cholesterol levels. Chromium deficiency results in insulin resistance and lipid abnormalities have also been reported.[2,24] Foods rich in beta-carotene protect the cells from the damaging effects of free radicals, provide a source of vitamin A, enhance the functioning of the immune system and maintain a healthy reproductive system. Food sources of beta-carotene include sweet potatoes, carrots, spinach, turnips and green leaf vegetables.[2,25,26] It is possible that the significant difference in carotene intake between the groups was due to the low consumption of hard vegetables (especially carrots) in orthodontic patients during the treatment. The lower intake of fibre and vitamin C (although not significantly different) in orthodontic patients in comparison with control subjects is consistent with this finding. Riordan's[15] results demonstrated that the intake of copper and manganese decreased significantly after orthodontic adjustment; however, in the present study, although the intake of these two elements was lower in the Orthodontic group, the difference was not statistically significant.

The results of Riordan's[15] study of the dietary changes and nutrient intake before and after orthodontic adjustment reflected the short study time frame. Alterations in nutrient intake are likely to occur over longer-term orthodontic treatment. Past studies have demonstrated that an adaptation to pain and discomfort occurs during the first week after the placement of the orthodontic appliances.[27–32] In the present study, the 24-hour memory recall was obtained approximately three or four weeks after the orthodontic adjustment visit, at a time when patients were experiencing little pain and pressure sensitivity. However, the results indicated that nutrient intake had been affected and likely due to poor dietary behaviour established during the treatment rather than from short-term discomfort.

A limitation of the present study is its cross-sectional design. It is not possible to be certain that the associations between fixed orthodontic therapy and the nutrient intake of the patients are directly related. The 24-hour recall method of data collection requires individuals to remember the specific amounts of food consumed in the previous 24 hours.[2] Patients did not anticipate that their diet was being analysed and therefore ate normally. However, the inability to accurately recall and the uncertainty regarding the patient's normal intake, produce possible flaws in the methodology.[2]

According to Proffit,[33] patients with severe malocclusion often have difficulty in normal mastication. These individuals have learnt to avoid certain foods that are hard to incise and chew, and may have problems with cheek and lip biting.[33] Therefore, it is possible that an altered nutrient intake during orthodontic treatment could be due to the malocclusion and not the orthodontic therapy per se. Therefore, to eliminate this bias, matched control subjects were selected and assessed from individuals who were awaiting orthodontic therapy.

Conclusions

Fixed orthodontic therapy may have an associated bearing on the nutrient intake of patients. In the present report, the most important changes were in the intake of foods containing fats and fibre.

A significantly higher intake of fat and lower intake of fibre were characteristics of orthodontic patients in comparison with a matched Control group. This may increase the risk of cardiovascular diseases and cancer in these patients.

It is recommended that nutritional guidance be provided to orthodontic patients and in this respect, the help of a dietitian may be worthwhile.

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