A randomized clinical trial comparing the efficacy of mandibular implant-supported overdentures and conventional dentures in diabetic patients. Part IV: Comparisons of dietary intake

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Statement of problem. It is unclear whether the replacement of conventional mandibular dentures with implant-supported overdentures alters the diet and thus improves the nutritional intake of edentulous persons.

Purpose. The purpose of this study was to compare the pretreatment and posttreatment diets of edentulous diabetic patients who received new dentures with either a conventional complete mandibular denture (CD) or a mandibular implant-supported overdenture (IOD).

Material and methods. New dentures were made for 89 edentulous diabetic patients with acceptable metabolic control without insulin (NIT) or with insulin (IT). A randomized approach was used to assign 37 patients a mandibular CD and 52 patients a mandibular IOD supported by 2 cylindrical implants. Of the 89 patients, 58 submitted a dietary log for 7 consecutive days before treatment (PT) and 6 months after treatment completion (PTC). An average daily intake of 28 essential nutrients was determined for each patient at each time interval. Separate $2 \times 2 \times 2$ repeated analysis of variance (ANOVA) tests were performed for each nutrient to compare the means of the 2 denture groups (CD and IOD), 2 diabetic groups (NIT and IT), and 2 time intervals (PT and PTC). The intakes were also compared with the recommended daily allowance (RDA).

Results. ANOVAs for all 28 nutritional variables showed no main effect for either denture type or diabetic treatment. Time effects were seen for magnesium, potassium, copper, and monounsaturated fats. The PTC mean intake of the total sample (N = 58) decreased for all 3 minerals and increased for monounsaturated fats with study dentures. Post hoc tests showed the differences between PT and PTC means to be statistically significant for only magnesium (P=.043) and potassium (P=.015). The percentage of patients with PT intake 25% or more below the RDA ranged from 33% to 85% in the CD group and from 24% to 100% in the IOD group for the same 11 nutrients. PTC fiber intake deficiency was noted in almost all participants. Carbohydrate consumption was markedly lower than that recommended by the American Diabetic Association.

Conclusion. As is often the case with elderly groups, this group of edentulous diabetic patients showed highly comprised nutritional intakes of fiber, vitamins, and minerals. The replacement of old dentures with new dentures that included either a mandibular CD or IOD did not alter patient diets such that the patients improved their nutritional intakes of essential micronutrients and macronutrients. (J Prosthet Dent 2001;85:53-60.)

CLINICAL IMPLICATIONS

Dentists should be concerned with the prevalence of deficient intakes of minerals and vitamins in elderly edentulous patients. New dentures with mandibular conventional or implant-supported overdentures are not likely to improve the compromised nutritional status of such patients.

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Previous studies have shown that the chewing ability of an average person with complete dentures is about 20% of the chewing ability of an average person with complete dentition.[1,2] The effect of this functional impairment on dietary intake and nutritional health status has been a matter of great concern for health care providers, especially because denture wearers are predominantly elderly persons with low socioeconomic status. A substantial percentage of them wear poorly fitting dentures,[3] which may lead to excessive discomfort, decreased denture use, and avoidance of certain foods. A few cross-sectional studies[4-7] have found that denture wearers prefer easy-to-chew foods.

The results of many dietary surveys[8-14] have reported that the intakes of calories, vitamins, and minerals are inadequate in many elderly persons with and without dentures. The associations observed between food consumption and cardiovascular disease and cancer in recent surveys indicate a need to improve the functional capacity of denture wearers. Although a variety of procedures, including the use of dental implants, have been used to improve denture retention and stability, most previous studies have failed to show changes in dietary intakes after the replacement of poorly fitting dentures with new dentures or implant-supported prostheses.[15-20]

The current randomized clinical trial[21] was undertaken to make comprehensive comparisons of the efficacies of mandibular implant-supported overdentures (IOD) and conventional dentures (CD) in controlled diabetic patients. The implant overdenture had plastic clip retainers for a Hader bar connecting 2 IMZ implants placed in the right and left canine areas. Although these 2 types of dentures failed to increase masticatory performance,[22] patients in both groups perceived marked improvements in their chewing comfort.[21] Between 20% and 30% more patients in the IOD (compared with the CD group) perceived improvements in chewing ability, chewing comfort, or food choices.[23] The purpose of this study was to compare changes in the dietary intake of 30 essential nutrients before and after the insertion of the 2 types of study dentures previously mentioned.

MATERIAL AND METHODS

The detailed study design, method, and a number of outcomes have been reported previously.[21-23] A total of 102 edentulous patients who controlled their diabetes with insulin (IT) or without insulin (NIT) were enrolled and randomized to receive either complete maxillary and mandibular new conventional dentures or maxillary conventional and mandibular implant-supported overdentures. The treatment was considered complete 30 days after the insertion of study dentures.

Participants submitted to detailed oromaxillofacial examinations and a series of functional tests at entry, before treatment (PT), and at 6 months after treatment completion (PTC). They were given data sheets and instructed (both verbally and through written materials) to maintain a complete food intake log for 1 week (7 consecutive days) before their treatment was initiated and for 1 week after the 6-month treatment completion. The data sheets included sections for recording the type and amount of food consumed for breakfast, lunch, dinner, and snacks between the major meals. Participants were asked to make these entries as soon as possible after eating. For certain dishes with multiple food items, they were asked to identify the main ingredients. They mailed the completed forms or submitted them in person to the office of the Study Coordinator.

Each food item was coded according to the USDA Dietary Analysis Program (No. PB90-500026, NTIS, Springfield, Va.) by trained technicians. This program uses a database of 850 commonly used food items in generic and name brands. In the absence of an individual item in the directory, its constituent items (for example, the items in certain casseroles and sandwiches) were entered in proportion to the total amount. When a particular item in the log could not be matched to an entry in the database or easily broken down to its constituents, 1 of the investigators (N.G.) provided the technician with coded entries from the USDA database that approximated the nutritional content of the food item. A summary of the 7-day diet was prepared for each participant. The dietary analysis program established scores for water content and 29 nutritional variables, including total caloric intake, fats, proteins, carbohydrates, fiber, cholesterol, alcohol, and a number of minerals and vitamins. The 7-day score was averaged for each of the 29 nutrients to estimate daily intakes for each participant.

Table I. Status of study patients in terms of treatment completion and submission of pretreatment (PT) and posttreatment (PTC) dietary logs

	Number of patients		
	CD	IOD	Total
Entered	40	62	102
Withdrew before receiving study dentures	3	10	13
Received study dentures	37	52	89
Failed to submit PT dietary log	7	5	12
Treated/completed PTC tests	30	47	77
Failed to submit PTC dietary log	9	10	19
Submitted both PT and PTC dietary logs	21	37	58

CD = Conventional denture group; *IOD* = implant overdenture group.

Study population

The actual number of patients with and without dietary data at different study intervals is given in Table I. Thirteen patients withdrew before or during treatment. Among the 89 who completed treatment, PT dietary logs were not received for 7 of the 37 patients in the CD group and 5 of the 52 patients in the IOD group. Although 77 patients completed tests at 6 months PTC, 9 patients in the CD group and 10 in the IOD group failed to submit the dietary logs. This meant that both the PT and 6-month PTC dietary logs were available for 58 patients, 21 in the CD group and 37 in the IOD group. The logs for these 58 patients were used to determine treatment effects in terms of changes in nutritional intake with study dentures.

Data analyses

Alcohol consumption was excluded from the analyses because only 3 patients in the CD group and 4 in the IOD group listed alcohol in their PT dietary logs. Means and standard deviations were calculated for PT and PTC consumption of 28 nutrients in the 2 diabetic treatment groups (IT, NIT) as well as for the 2 denture groups (CD, IOD). Separate $2 \times 2 \times 2$ repeated measures analysis of variance (ANOVA) tests were performed to compare mean scores for each nutrient between the 2 denture groups and between the 2 diabetic groups at 2 time intervals (PT and PTC). When a significant ANOVA F ratio was found, *t* tests were performed to determine the variable with significant mean difference. The percentages of patients consuming more or less than 25% of the recommended dietary allowances[24] (RDAs) for each nutrient were also calculated and compared for the 2 denture groups at PT and at the 6-month PTC. Two-tailed Fisher exact tests were used to determine the statistical significance of differences between percentage distributions. An alpha level of .05 was used for all statistical analyses.

RESULTS

Effect of patients who withdrew from the study

The effect of the 19 patients who failed to submit PTC dietary logs on the remaining study sample of 58 patients with complete dietary data was determined in 2 ways. First, the PT mean intakes of each of the 28 nutrients for the 19 patients who withdrew from the study were compared with those of the remaining 58 patients. Second, comparisons were made between the PT mean scores of the 9 withdrawals and the remaining 21 in the CD group and between the 10 withdrawals and remaining 37 in the IOD group. With 1 exception, ANOVAs in 3 sets of comparisons failed to show any significant mean differences between the withdrawals and the remaining study sample. The only exception was that the mean intake of 21.8 g saturated fatty acids for the 19 withdrawals was significantly higher than the mean intake of 18.8 g for the remaining 58 patients.

Pretreatment and posttreatment dietary intakes

The PT mean scores and standard deviations of the 28 nutrient intakes for the CD and IOD groups are presented in Table II. The PT and PTC intake means for most of the 28 nutrients were quite similar in the IT and NIT as well as in the CD and IOD groups. The actual changes in PTC mean scores from PT means and percentage changes for the CD and IOD groups are shown in Table III. The mean intakes with study dentures decreased for 26 nutrients in the CD group and 20 nutrients in the IOD group. Mean decreases of 19.8% to 26.4% for 5 nutrients (Vitamin B-12, Vitamin A-RE, iron, Vitamin A-IU, and carotene) occurred with study dentures in the CD group; mean decreases of 21.9% for ascorbic acid and 23.3% for carotene occurred in the IOD group. All other decreases in mean intakes were less than 15% in both

Table II. Pretreatment means and standard deviations of daily dietary intakes for conventional denture (CD) and implant overdenture (IOD) groups

	CD (N = 21)		IOD (N = 37)	
Item	$\bar{X}$	SD	$\bar{X}$	SD
Food energy (kJ)	6,597.7	2,190.41	6,600.7	1,803.97
Protein (g)	75.5	24.85	80.3	22.08
Total fat (g)	53.5	22.53	54.6	20.75
Saturated fat acids (g)	17.8	8.37	19.4	8.20
Monounsaturated fat (g)	19.9	9.69	20.1	8.06
Polyunsaturated fat (g)	10.9	4.51	10.3	3.62
Cholesterol (mg)	225.6	96.37	297.3	155.90
Carbohydrate	202.9	82.01	189.5	54.62
Fiber	19.8	13.01	15.2	5.22
Vitamin A (IU)	10,573.7	5,738.92	8,858.4	5,621.11
Vitamin A (RE)	1,556.8	1,000.62	1,385.0	944.63
Carotene (mg)	807.4	518.60	635.5	435.08
Alpha tocopherol	9.0	12.79	6.2	2.28
Ascorbic acid (mg)	97.9	49.92	103.8	60.68
Thiamin (mg)	1.6	0.98	1.5	0.50
Riboflavin (mg)	2.0	1.18	1.8	0.68
Niacin (mg)	24.5	14.47	22.0	7.01
Vitamin B_6	2.0	1.24	1.8	0.66
Folacin (mg)	329.3	253.48	268.7	133.23
Vitamin B_{12} (mg)	5.2	4.25	5.1	3.63
Calcium (mg)	700.3	307.03	730.8	329.65
Phosphorus (mg)	1,169.1	492.58	1,185.1	362.41
Magnesium (mg)	289.6	142.74	271.9	74.83
Iron (mg)	18.1	17.62	13.8	4.82
Zinc (mg)	10.4	5.60	10.1	3.06
Copper (mg)	1.3	0.54	1.2	0.34
Sodium (mg)	3,129.0	974.41	3,112.0	1,031.91
Potassium (mg)	2,690.9	804.42	2,658.6	769.43

groups. The PTC increases were less than 10% and occurred for only 2 nutrients in the CD group and 8 nutrients in the IOD group. No PTC changes were significant (P=.05).

ANOVAs for each of the 28 nutritional variables showed no main effects for either denture type or diabetic treatment. Significant time effects (PT and PTC) were found for magnesium, copper, and potassium, and a 3-way interaction (time × diabetic treatment × denture type) was noted for monounsaturated fats. The t tests showed that the mean differences between the 2 diabetic groups and between the 2 denture groups for these 4 nutrients were not significant at either PT or PTC intervals. Comparisons between mean intakes for the entire sample (N = 58) for these 4 nutrients are shown in Table IV. The mean intakes of all 3 minerals decreased with study dentures, whereas the mean intake of monounsaturated fats increased slightly. The differences between PT and PTC mean scores were statistically significant for magnesium (P=.043) and potassium (P=.015), marginally significant for copper (P=.055), and insignificant for monounsaturated fats (P=.565).

Comparisons of dietary intakes and recommended dietary allowances

Each patient's consumption of each nutrient was compared with the RDA. Adjustments for age, gender, and weight were made for caloric intakes. The percentages of patients with intakes of 25% below the RDA in the CD and IOD groups at PT and 6 months PTC are shown in Table V. More than 24% of participants in the CD and IOD groups showed such deficient intakes at PT for 11 nutrients. In addition, deficient intake of Vitamin A was found for 24.3% of the IOD group. No significant changes in percentage distributions were noted with study dentures in either denture group. All the patients in the IOD group had fiber intakes of 25% or more below the RDA at both time intervals; in the CD group, more than 85% at PT and 95% at PTC had such intake deficiency. Comparisons between the 2 groups showed a significant percentage difference only for PT fiber intakes and PTC folacin in favor of the CD group. The percentage distributions for the remaining 17 nutrients were similar at both time intervals.

DISCUSSION

It is apparent that the intake of neither calories nor the other 27 nutrients tested in this study were significantly affected by the study dentures in this group of diabetic patients with clinically acceptable metabolic control. This was true regardless of whether the study dentures included a mandibular conventional denture or an implant-supported overdenture. The PTC mean caloric intakes decreased by 356.5 kJ (2.3%) in the CD and by 93.3 kJ (1.4%) in the IOD groups with study dentures. Although substantial percentage changes from PT intake levels were observed with study dentures for some nutrients in a number of patients in both denture groups, the PT and PTC mean percentage differences were not significant for any of the 28 nutrients.

The dietary intakes for the entire group of 58 patients were examined with respect to the RDAs for adults and the recommendations of the American Diabetic Association (ADA) for Class II diabetic patients. The ADA recently discarded its exchange list-based diabetes diet for an individualized dietary regimen based on the weight, systemic health, and daily activities of a patient.[25] The medical nutrition therapy is now considered an integral part of the treatment for diabetes in adults. Its purpose is to maintain or attain proper body weight, optimum serum lipid levels, and near-normal blood glucose levels by monitoring and adjusting the diets of individual patients. The recent ADA recommendations[26] for patients with Type 2 diabetes require a reduction of 1050 to 2100 kJ from the RDA levels with caloric contributions of less

Table III. Posttreatment change in mean scores (pretreatment mean minus posttreatment mean) and percentage change from pretreatment dietary intakes for conventional denture (CD) and implant overdenture (IOD) groups

	Mean change from pretreatment		% Change from pretreatment	
Item	CD (N = 21)	IOD (N = 37)	CD (N = 21)	IOD (N = 37)
Food energy (kJ)	–356.5	–93.3	–5.4	–1.4
Protein (g)	–7.4	–2.1	–9.8	–2.6
Total fat (g)	–0.7	2.5	–1.4	4.5
Saturated fat acids (g)	–0.4	0.8	–2.4	4.0
Monounsaturated fat (g)	–0.2	1.1	–0.9	5.5
Polyunsaturated fat (g)	–0.0	0.4	–0.0	4.4
Cholesterol (mg)	22.1	1.06	9.8	3.6
Carbohydrate	–14.8	–5.7	–7.3	–3.0
Fiber	–2.9	–0.2	–14.7	–1.4
Vitamin A (IU)	–2481.5	–680.4	–23.5	–7.7
Vitamin A (RE)	–316.5	–134.8	–20.3	–9.7
Carotene (mg)	–213.2	–155.3*	–26.4	–23.3
Alpha tocopherol	0.1	0.2	1.6	2.9
Ascorbic acid (mg)	–1.6	–22.7	–1.7	–21.9
Thiamin (mg)	–0.1	–0.1	–7.1	–5.9
Riboflavin (mg)	–0.2	–0.0	–12.8	–0.9
Niacin (mg)	–2.9	–1.1	–11.7	–5.0
Vitamin B_6	–0.2	–0.2	–9.4	–11.1
Folacin (mg)	–46.0	–28.3	–14.0	–10.5
Vitamin B_{12} (mg)	–1.0	–0.4	–19.8	–8.8
Calcium (mg)	–82.9	19.1	–11.8	2.6
Phosphorus (mg)	–150.8	–7.9	–12.9	–0.7
Magnesium (mg)	–31.8	–16.2	–11.0	–5.9
Iron (mg)	–4.0	–0.7	–22.2	–5.3
Zinc (mg)	–1.3	–0.1	–12.1	–0.6
Copper (mg)	–0.2	–0.1	–13.6	–6.3
Sodium (mg)	–410.7	7.0	–13.1	0.2
Potassium (mg)	–272.5	–168.2	–10.1	–6.3

*Two outliers were excluded.

than 30% from total fats, between 10% and 20% from proteins, and 60% to 70% from carbohydrates and monounsaturated fats.

The mean weight of the study participants was 186.9 lb, and the mean height was 67.1 in. The average study participant was 26.9 lb over the upper limit of the recommended weight of 160 lb.[27] The caloric intake for the participants ranged from 3,230 to 12,623 kJ with a mean of 6,410 kJ/d; the mean represents approximately 63% of the RDA for a 65-year-old healthy adult man who weighs 185 lb. The energy intakes were within 25% of the RDA in 52% of the patients, below this limit in 31% of the patients, and above this limit in 17% of the patients. Mean energy intakes of 75% to 80% of the RDA were reported in other studies of elderly denture wearers and elderly diabetic patients.[28,29] Underreporting can be a factor in dietary surveys, especially those involving diabetic patients who are under dietary surveillance and are expected to reduce their caloric intakes. Proteins provided 19%, fats 32%, and carbohydrates 48% of the calories. The fats were composed of 11.7% saturated, 6.6% polyunsaturated, and 12.7% monounsaturated types. The mean protein consumption for this group reached the upper limit of 20%, and the mean total fat exceeded the 30% limit of the ADA recommendations by 2%, primarily because of the 11.7% consumption of saturated fat compared with the 10% upper limit.

The PT intakes of 10 nutrients were 25% below the RDA limits in more than 35% of the study sample. The frequency distributions of all 58 patients by their intakes relative to the RDA for calories, fats, carbohydrates, and cholesterol are shown in Figure 1; the distributions for their intakes relative to the other 5 nutrients are shown in Figure 2. More than 60% of the patients failed to meet the RDA for all 10 nutrients. Fat intake was 25% below the RDA in 48% of the patients, and cholesterol intake was 25% below the RDA in 41% of the patients; only 9% of the patients consumed fats and 17% consumed cholesterol at 25% above the RDA levels. This indicates that patients in this study were better at restricting their total caloric, fat, and protein intakes than diabetic

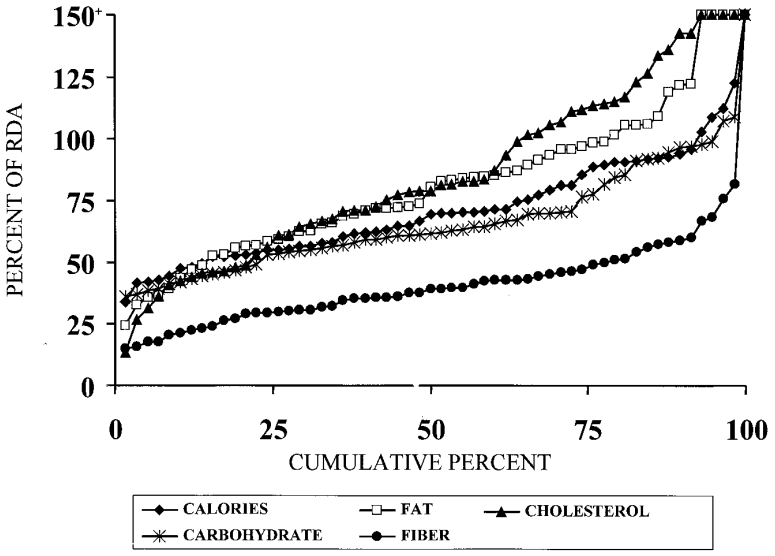

Fig. 1. Cumulative frequency distributions (N = 58), expressed as percentage of RDA values, for intake of calories, fats, carbohydrates, fibers, and cholesterol.

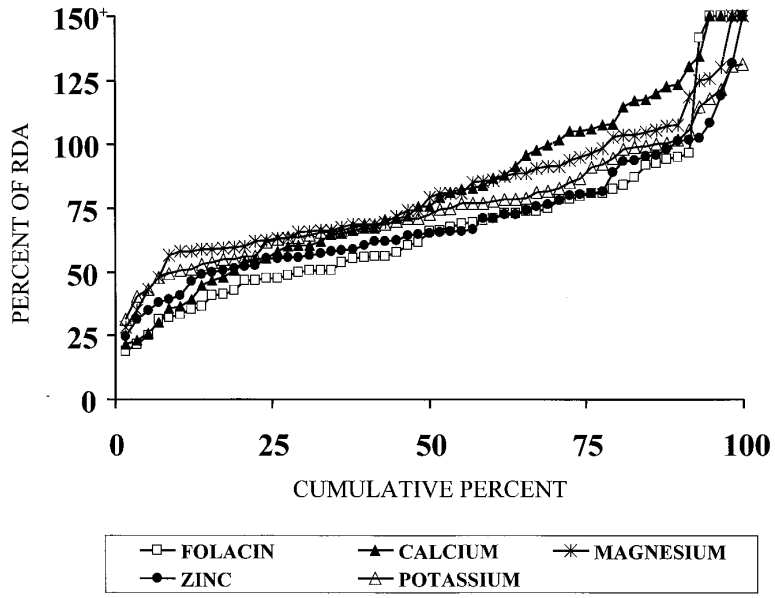

Fig. 2. Cumulative frequency distributions (N = 58), expressed as percentage of RDA values, for intake of folacin, calcium, magnesium, zinc, and potassium.

patients who exhibited poor compliance with dietary guidelines in other recent nutritional surveys of diabetic patients.

However, the total energy that patients in this study derived from carbohydrates did not meet RDA standards. More than 71% of the participants consumed carbohydrates at 25% below the RDA. Less than 50% of their total mean energy was derived from carbohydrates. This might explain the low mean fiber intake of 15 g compared with 20 to 35 g recommended by the ADA. The fiber intake was 25% below the RDA level in 98% of the patients and 50% below the RDA level in 75% of the patients. These numbers are disconcerting because of the beneficial effects of fiber on gastrointestinal disorders, colon cancer, and serum lipids. As can be seen in Figure 2, deficient intakes of 25% below the RDAs were found in 52% of the patients for calcium, 53% for magne-

Table IV. Pretreatment and posttreatment means and standard deviations of intakes in the entire group of 58 patients for 4 nutrients with significant analysis of variance F ratio

	Pretreatment		Posttreatment		
	$\bar{X}$	SD	$\bar{X}$	SD	*P* value
Monounsaturated fat (g)	20.0	8.60	20.7	8.65	.565
Magnesium (mg)	278.3	103.73	265.5	78.30	.043
Copper (mg)	1.2	0.42	1.1	0.34	.055
Potassium (mg)	2670.3	775.37	2464.4	763.27	.015

sium, 69% for folacin, 71% for zinc, and 67% for potassium. Similar considerable intake deficiencies for micronutrients generally have been observed in elderly groups with and without dentures.[8-14]

The results of this study support the finding of most previous studies, namely, that the clinical quality of dentures or other prosthodontic treatment has no impact on dietary intake.[15-20] This has been true with and without positive treatment effect on objective and/or subjective chewing ability. Several factors may help explain the lack of a meaningful association between dietary intake and a change in dentition status, resulting in significant impairment of chewing ability. It is recognized that eating behavior and food preferences develop over an extended period and are influenced by a variety of socioeconomic, ethnic, and psycho-physiologic factors.[30] Significant impairments in chewing ability associated with chronic dental diseases or edentulousness often occur over many years with the gradual loss of teeth. Any functional impairment resulting from the loss of a few teeth may or may not impact the intake of nutrients. Individuals, whether they do or do not use nutritional supplements, may select foods that are easier to chew but that still provide essential nutrients.

It is more likely that a sudden loss of a significant number of teeth can contribute to a dramatic change in diet. Even this shift in food choices may or may not be accompanied by a change in nutritional value. Such a functional impairment is more likely to affect the selection of food in terms of chewing difficulty and the pleasures derived from eating. To our knowledge, no controlled studies have been undertaken. Most dietary studies have analyzed food intake in terms of nutritional content rather than physical characteristics. However, a cross-sectional study showed that persons with dentures or compromised dentition preferred easier-to-chew foods than did persons with partially compromised or intact dentition.[6] Similar data on food choices as well as foods consumed in the present cohort are being analyzed to determine the effects of study dentures on food choices and changes in diet in terms of chewing difficulty of foods.

Table V. Percentages of patients in CD and IOD groups with pretreatment and posttreatment intakes of 25% below RDA

	% Patients with intakes of 25% below RDA			
	Pretreatment		Posttreatment	
	CD	IOD	CD	IOD
Calories	66.7	67.6	42.9	24.3
Protein	9.5	2.7	4.8	0.0
Total fat	47.6	48.7	52.4	46.0
Cholesterol	47.6	37.8	42.9	27.0
Carbohydrates	61.9	78.4	66.7	73.0
Fiber	85.7	100.0	95.2	100.0
Vitamin A (IU)	9.5	24.3	23.8	27.0
Thiamin	14.3	2.7	14.3	13.5
Riboflavin	14.3	5.4	9.5	10.8
Niacin	4.8	2.7	9.5	0.0
Vitamin B_6	33.3	24.3	42.9	35.1
Folacin	61.9	70.3	71.4	67.6
Vitamin B_{12}	0.0	2.7	9.5	10.8
Calcium	47.6	43.2	61.9	46.0
Phosphorus	4.7	5.4	9.5	10.8
Magnesium	52.4	5.4	9.5	10.8
Iron	4.8	8.1	4.8	10.8
Zinc	66.7	64.9	85.7	62.2
Sodium	4.8	5.4	9.5	2.7
Potassium	47.6	56.8	66.7	67.6

CD = Conventional denture; *IOD* = implant overdenture; *RDA* = recommended daily allowance.

CONCLUSIONS

New dentures with either a mandibular conventional or an IOD did not significantly alter the dietary intakes of participants with acceptable metabolic control of diabetes. This was true whether the metabolic control was maintained with or without insulin. The results confirm the findings of many previous studies that showed that dietary habits, in terms of nutritional intake, are not readily changed or influenced by the type of prostheses in edentulous patients. These habits probably develop over a long period and are influenced by a variety of socioeconomic, cultural, and behavioral factors. Therefore, it is important for dentists to repeatedly provide nutritional counseling to their patients.

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