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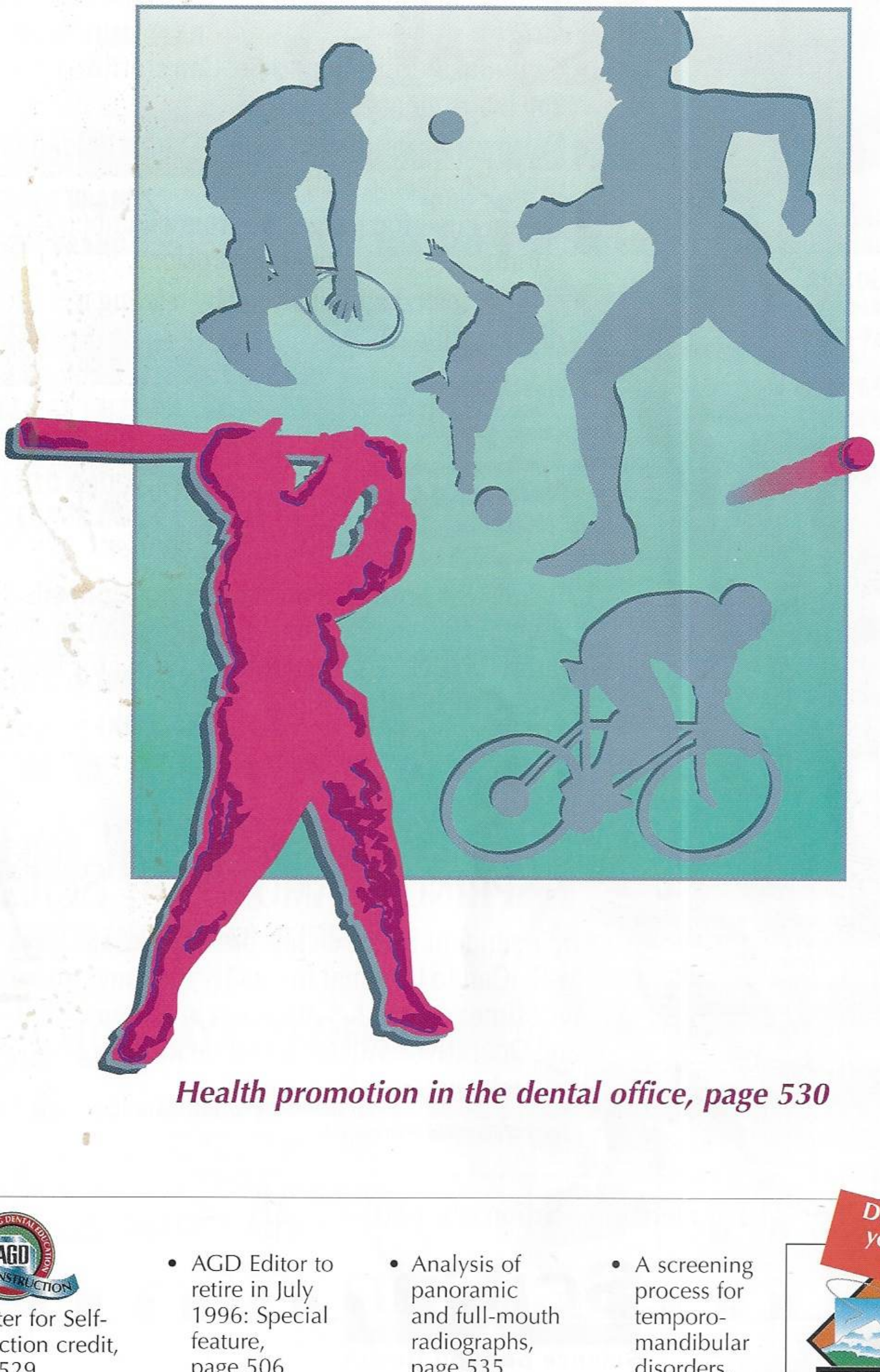

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Vitamin C and dental healing. III: The nutrition factor

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Discovery of natural healing substances has spanned recorded history. Use of medicinal plants and animal products dates back to prehistoric times,[1-3] and continues to be a prominent feature of traditional ethnomedical systems worldwide.[4-6] In many populations, botanical preparations have been applied successfully in the treatment of an assortment of health problems, including skin irritations, insomnia, sexual dysfunction, hypertension, diabetes, arthritis, and digestive disorders.[7-9]

According to ample evidence from chemical analyses, some herbal medications contain potent biodynamic ingredients that deliver the desired effects.[10-13] This significant finding has sparked manufacturing of various synthetic biomedical drugs. Aspirin (birch bark), quinine (cinchona bark), digitalis (foxglove leaves), and paclitaxel (Taxol, yew tree bark) are examples of modern medicines that were obtained from raw plant sources. Ongoing horticultural experimentation in different societies has led to the discovery of other useful organic medicinal substances, such as analgesics, appetite stimulants, tranquilizers, and sedatives.[14-18]

In recent years, a new dimension has been added to the search for healing materials, namely, the realization that many common foods possess medicinal qualities. Garlic, onion, ginseng, chicken broth, and several species of cactus and mushroom have been considered healthful and curative for many years in a variety of traditional cultures. Natural and synthetic vitamins, minerals, and other nutrients have been prescribed in treatment of diseases and injuries in western societies as well.[19-22]

As part of a larger research project, the study reported on here was conducted to test the hypothesis that postsurgical ingestion of particular food nutrients, including dietary vitamin C, promotes recovery from tooth extractions. Previously, we indicated that supplemental vitamin C (1,000 to 1,500 mg/day) significantly enhanced recovery, and reduced complications from minor oral surgery in single- (N = 452) and double-blind/placebo (N = 161) experimental designs.[23,24]

Materials and methods

Following the same procedures as in our earlier studies, 83 additional consecutive tooth-extraction patients (39 men, 44 women; 19 to 62 years of age) at a high-volume dental clinic in Miami were studied. One dentist extracted all teeth in a standardized fashion, with the same types of equipment, under the same general conditions, as previously. All patients received the identical list of instructions for postsurgical dental care that is provided routinely to clinic patients.

Soft foods—pudding, soup, peanut butter, yogurt, milk, eggs, applesauce, cottage cheese, etc.—were recommended for the recovery period, but patients were told not to limit themselves to these, and to eat whatever felt comfortable, pleasing, and desirable.[25] Each patient was given a special form on which to record a detailed diary of all food and beverages—including portions and sizes—consumed postoperatively. Pain medications were prescribed—acetaminophen/codeine phosphate (Tylenol III) or propoxyphene napsylate (Darvon N-100)—but supplemental vitamin C or placebos were not provided, unlike in our earlier investigations.

The 83 patients returned to the clinic 1 week postsurgically for a follow-up evaluation, and discussion of pain, diet, and other aspects of recovery. As in previous trials, the Melzack scale was used to assess pain expression.[26] Healing during the week after extraction was classified (as before) in one of two ways, according to criteria suggested by Dubois et al.:[27]

Type 1—slow healing: expression

Table 1. Healing progress and incidence of alveolalgia (dry socket) according to supplemental Vitamin C status

Postoperative medication	% slow healing	% rapid healing	% incidence of dry socket
Vitamin C (n = 358)	13.1	86.9	1.1
Placebo/ no vitamin C (n = 255)	36.5	63.5	7.1
Total (N = 613)	22.8	77.2	3.6

Table 2. Nutrient constituents of patients' postoperative diets (7 days); N = 28 (slow healing) and 55 (rapid healing)

Nutrient	Category of patient*	Mean	SD
Vitamin A (IU)	SH	8,506.3	7,432.3
	RH	12,308.1	10,551.5
Vitamin B_6 (mg)	SH	3.3	2.5
	RH	4.1	3.5
Vitamin B_{12} (mcg)	SH	9.0	5.4
	RH	11.7	12.2
Vitamin C (mg)	SH	395.9	317.5
	RH	554.2	382.6
Magnesium (mg)	SH	569.0	336.5
	RH	632.1	361.6
Calcium (mg)	SH	2,219.6	1,264.8
	RH	2,936.9	1,787.2
Iron (mg)	SH	31.3	12.8
	RH	34.4	15.9
Zinc (mg)	SH	18.2	11.7
	RH	20.5	14.1
Copper (mg)	SH	2.4	2.2
	RH	2.6	3.0
Manganese (mg)	SH	3.5	2.9
	RH	4.7	3.7
K calories	SH	5,230.3	2,316.2
	RH	5,972.4	2,576.9
Protein (g)	SH	205.2	94.7
	RH	253.0	102.3

*SH = slow healing; RH = rapid healing

of pain, request for additional analgesic, edema, purulence, weak-to-moderate granulation-bed formation, and antibiotic prophylaxis required (erythromycin or penicillin, or both); and

Type 2—rapid healing: no expression of pain (or expression of mild pain without the need for additional analgesic), no edema nor swelling, no clinical infection (e.g., no purulence), complete granulation-bed formation, and no antibiotics nor other medications required.

Patients' postoperative intake of several dietary nutrients and the possible correlation with healing were analyzed extensively. Protein, calorie, vitamin (A, B_6, B_{12}, and C) and mineral (magnesium, calcium, iron, zinc, copper, and manganese) consumption during the week of recovery were determined from the submitted food and drink diaries. Particular dietary items and quantities consumed (e.g., tuna sandwich on whole-wheat bread, bowl of tomato soup, serving of applesauce) were converted to nutrient constituents (amount of protein expressed in grams; number of calories expressed in KCAL.; and units of vitamins and minerals expressed in µg, mg, or IU) according to *Bowes and Church's Food Values of Portions Commonly Used, ed. 15.*[28] A research assistant, in single-blind fashion—i.e., without knowledge of patients' eventual healing-progress categories—made the conversions independently of the evaluations of healing. All items of food and drink reported by patients were converted to nutrient content according to tables and scales in the conversion guide.[28]

Results

In the two earlier phases of the project, according to χ^2 and matched (paired) sample *t*-test values, ascorbic acid supplementation correlated strongly with rapid healing (p = .0002 to .0009); gender, age, occupation, medical history, and other demographic and clinical characteristics of patients (N = 613) were not statistically associated with healing rates. Incidence of alveolar osteitis (dry socket), a painful condition used as an indicator of faulty recovery, was significantly higher in the "no-vitamin C" and "placebo" groups. In Table 1, the cumulative results of the first 2 segments of the research are summarized.

Independent analyses of the diets of the 83 additional control subjects (who did not receive or use supplemental ascorbic acid or placebos) permitted quantification of 10 food nutrients (4 vitamins, 6 minerals) and total calorie and protein intake. The Statistical Package of the Social Sciences computer program was used to cross-tabulate the derived nutrient values by healing-rate categories, and to perform *t*- and analysis of variance (F) tests to determine significant correlations.[29] Of the 83 patients studied here, 28 (33.7 percent) were classified as Type 1 (slow healing); the other 55 (66.3 percent) were Type 2 (rapid healing), according to our criteria.

Results of the dietary nutrient conversions are presented in Table 2. Mean intake values for the seven-day recovery period are compared for slow- and rapid-healing patients.

Patients classified as rapid healing subsequently were discovered to have higher average nutrient intake levels across the board. F and *t* values indicate that the differences between slow- and rapid-healing patients—with respect to postoperative vitamins A and C, calcium, and total protein ingestion—were statistically significant ($p < .05$). Associations between healing rates and consumption levels of manganese, vitamin B_{12}, and total calories were statistically weaker ($p < .20$).

The elevated standard deviations (SDs) in Table 2 suggest appreciable variation between individuals, with regard to ingestion of nutrients, especially vitamin A and calcium, and total calorie intake. Intermediate ranges of variation characterize postoperative consumption of vitamin C, magnesium, and protein; with respect to the remaining nutrients, intake values were relatively uniform. These variations might be the result of differences in food preferences and choices among the sampled tooth extraction patients, but the variations might reflect different levels of pain and discomfort and tolerance of them during the recovery period, especially during eating.

For the seven-day recovery period, intake ranges of tested nutrients, according to healing-progress categories, are presented in Table 3; both the slow- and rapid-healing groups had wide ranges. Not surprisingly, a number of patients fell short of average weekly recommended daily allowances (RDAs) of nutrients (calculated for both genders combined).[30,31]

As in our previous samples (divided into 4 age groups), neither gender ($p = .47$) nor age ($p = .52$) was statistically associated with

Table 3. Postoperative dietary nutrient intake ranges in slow-healing (N = 28) and rapid-healing (N = 55) patients compared to recommended dietary allowances for 7 days[30,31]

Nutrient	Category of patient*	Intake range	RDA
Vitamin A (IU)	SH	765-32,146	35,000
	RH	1,065-55,020	
Vitamin B_6 (mg)	SH	0.4-76	14
	RH	1-23	
Vitamin B_{12} (mcg)	SH	0.3-18	42
	RH	0.6-77	
Vitamin C (mg)	SH	26-1,314	420
	RH	76-1,736	
Magnesium (mg)	SH	101-1,527	2,800
	RH	153-2,197	
Calcium (mg)	SH	52-5,937	7,000
	RH	125-6,739	
Iron (mg)	SH	7-107	126
	RH	8-146	
Zinc (mg)	SH	2-88	105
	RH	4-343	
Copper (mg)	SH	0.4-10	14
	RH	0.2-105	
Manganese (mg)	SH	0.4-13	14
	RH	0.2-14	
K calories	SH	1,542-10,866	16,800
	RH	1,337-13,755	
Protein (g)	SH	82-959	315
	RH	62-1,658	

*SH = slow healing; RH = rapid healing

healing rates, according to χ^2 tests. Contrary to expectations, the factor regarding whether patients smoked did not correlate significantly with healing prog-ress, according to χ^2 values, although only 13 patients (15.7 percent) reported smoking cigarettes during the recovery period. Among smokers, 38.5 percent were classified as slow healers; among the nonsmokers, 32.9 percent were in the slow-healing group, compared to 33.7 percent overall in this category. The two patients with dry socket, both classified as slow healers, had low-end values for nearly all tested nutrients.

Discussion

The findings strongly suggest that certain dietary nutrients speed recovery from tooth extraction. Results indicate that higher dietary intake of ascorbic acid correlates positively with rapid clinical healing and reduced risk of complications. This finding corroborates our previous investigations of postoperative vitamin C supplementation, which was found to hasten postextraction healing, compared to placebos.

In our previous reports, clinical research was reviewed that suggests that vitamin C supplementation enhances dental healing through several mechanisms,[23,24] the most important of which may be the role of ascorbic acid in the synthesis of collagen, a nondietary protein and the principal structural constituent of scar (connective) tissue and tooth-socket granulation beds.[32-34] Concerning the role of vitamin C in connective-tissue formation and repair, Chatterjee observed: "Multiple roles, therefore, have been identified for the participation of vitamin C in connective-tissue formation. The vitamin is required for the biosynthesis of most of the components of connective tissues, and it is responsible for the structural integrity and stability of the components."[35] With respect to the relationship of ascorbic acid to postsurgical scar-tissue maintenance, Brin observed: "The human need for ascorbic acid both in wound healing and in the postsurgical maintenance of strong scar tissue is well-documented."[36]

Additional proven biodynamic advantages of ascorbic acid administration for postextraction tooth-socket repair include stimulation of the immune system and the lymphatic system, antibacterial activity of antibodies and enzymes, antioxidant activity that neutralizes the effects of free radicals (harmful chemical byproducts of oxygen metabolism), strengthening of blood clots, increased production of white blood cells, and catalyzing other physiological processes in wound healing. Vitamin C also accelerates the production of complement—a group of 20 serum proteins needed for antibodies to function properly.[36-39]

In the present study, the finding that higher intake levels of dietary calcium and protein are associated statistically with rapid postextraction recovery is supported by recent research. Calcium has an important role in osseous regeneration following trauma; increased protein intake contributes directly to synthesis and deposition of scar tissue and tooth-socket granulation beds.[40-42]

On the other hand, the present finding that vitamins A and B_{12}, and manganese might promote dental healing has not been substantiated fully in the literature. Vitamin A benefits maintenance and repair of epithelial tissue, and vitamin B_{12} reportedly helps to fight bacterial infection.[31,43]

The two cases of dry socket were characterized by low nutrient intake, but the condition probably is as much a cause as an effect of this correlation. Compared with the other tooth-extraction patients, the patients in excruciating pain from dry socket could not consume as much food postoperatively.

Conclusions

The present study augments the growing stock of evidence that nutrition is central to wound healing and recovery from minor oral surgery.[44] Further research is recommended to retest and reevaluate the hypothesis that dietary and supplementary nutrients influence the course of dental healing, particularly postextraction recovery, and the maintenance of postsurgical oral health. This investigation revealed extensive variation in postoperative consumption of some nutrients, and uniform consumption of others. It would be worthwhile to reexamine consumption patterns of nutrients in other oral surgery patients.

Periodontal diseases (among the most prevalent public health problems in the world) affect more than 30 percent of adults in the United States and up to 90 percent in other countries. Because many individuals inevitably face tooth extraction, the search should continue for new pathways to speed healing and recovery.[45] The results here indicate that dentists and oral surgeons might maximize positive outcomes of dental procedures by prescribing vitamins C and A, and possibly calcium supplements. Dental patients might benefit from the recommendation to ingest as much nutritious food as possible during recovery.

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