Is There an Association Between Edentulism and Nutritional State?

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Abstract

Edentulous people have difficulty chewing foods that are hard or tough in texture, even when wearing well-made dentures. These individuals typically modify their diets to compensate for loss of oral function. This practice leads to the question of whether the diet of edentulous individuals is adequate to maintain good general health.

This overview summarizes articles that describe the changes in diet associated with edentulism. Such changes include reductions in fruits, vegetables, meats and other hard-to-chew foods and are associated with compromised nutrition.

The evidence suggests that edentulous individuals lack specific nutrients and, as a result, may be at risk for various health disorders. The authors have recently shown that mandibular prostheses supported by only 2 implants may significantly improve nutritional status in edentulous patients.

MeSH Key Words: *aged; mouth, edentulous/complications; nutrition*

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Edentulous people have difficulty chewing foods that are hard or tough in texture, even when wearing well-made dentures.[1-5] Furthermore, there is ample evidence that they modify their diets and that even the foods they do eat are not always easy to chew.[6,7] This situation leads to the question of whether edentulous patients have adequate nutrient intake to maintain general good health. In this review, we discuss recent evidence suggesting that edentulous people do, in fact, lack specific nutrients and that these nutritional deficiencies could ultimately result in an increase in the incidence of various health disorders.

Epidemiology

The prevalence of edentulism stood at 17% in Canada in 1990[8] and currently rests at 9.7% in the United States for those aged 18 years or older.[9] The prevalence of this condition increases dramatically with age, and 33.1% of Americans aged 65 years or older suffer from edentulism;[9] the prevalence in this age group is comparable in various regions of Canada.[10,11] It is clearly this older age group that is most affected and best exhibits the physical consequences that this condition can impose.

Furthermore, elderly people will account for a greater proportion of the total population as the baby-boomer generation continues to age. For example, in 1998 Thompson and Kreisel[12] forecast a 36.5% increase in Canada's elderly population by the year 2015. Although both improved dental care and greater frequency of its use in recent years has led to a decline in the rate of edentulism, the expansion of the elderly population is still expected to result in increases in the need for various forms of oral health care.

Edentulism and Masticatory Function

The ability to chew a wide variety of foods of different textures and nutritional values is the principal benefit provided by the teeth. As tooth loss occurs, masticatory efficiency declines,[7] and it is natural for humans to alter their dietary intake to compensate for the greater difficulty of eating certain foods.[6,7] Edentulous individuals report significantly more chewing difficulties than dentate people, and they therefore constitute the group most likely to change

their diets.[13,14] Harder and more coarse foods such as fruits, vegetables and meats, which are typically major sources of vitamins, minerals and proteins, come to be regarded as either difficult or nearly impossible to chew. Consequently, a tendency to favour softer, more processed foods develops. However, these latter foods are typically fairly high in fat and cholesterol content and may also be lacking in vitamins and minerals.

Numerous studies have provided strong evidence of an association between diminished masticatory function and the amount of fruits, vegetables, meats and breads that individuals consume. Wayler and Chauncey[7] examined a sample of 814 subjects classified into 4 groups according to the extent of tooth loss and asked them to rate their ability to chew the following foods: pot roast, raw carrots, apples, pears, steak, crisp breads, peanuts, French bread, salami, cucumbers, celery, fried chicken, hard rolls, fried clams and coleslaw. After comparing the frequency of ingestion of hard and soft foods by the 4 groups, along with their ratings of chewing difficulty, the researchers concluded that "shifts in food selection patterns result from impairments in masticatory ability and appear to depend on the degree of impairment." Brodeur and others[15] noted a significantly higher intake of fruits and vegetables (by 13%) in subjects with high masticatory ability than in a group with low masticatory ability, whereas Johansson and others[16] witnessed a noteworthy lack of intake of fruits, vegetables and fibre in a group of edentulous men. Mäkilä[17] listed differences in the intake of a variety of foods consumed by dentate and edentulous populations: 24% of the dentate and 35% of the edentulous groups ate porridge, 46% and 21% respectively ate fruit, and 51% and 26% respectively ate meat. Findings from other studies[4,18-20] also indicate that subjects with more teeth tend to consume more hard-to-chew foods.

Altered Diet and Compromised Nutrition

If we accept that people with significant tooth loss eat fewer fresh fruits, vegetables and meats than fully dentate people, we must next question whether this difference in diet places edentulous individuals at higher risk of malnutrition. This question was recently addressed by Sheiham and others,[21] who reported the findings of the National Diet and Nutrition Survey (NDNS) in Great Britain. These authors tried to determine whether the oral health of independently living elderly people and those living in institutions had a noteworthy impact on their consumption of essential nutrients. The protocol included a dental examination, as well as 4-day weighted diet diaries, blood samples and urine samples to determine levels of selected nutrients expected to be most affected by the alterations in food intake brought about by edentulism.[21] Confounding effects of age, sex and numerous socioeconomic variables on the association between dental status and nutrition levels were taken into account in the statistical analysis.[21]

Among the people who were living independently, the intake of a variety of nutrients was significantly higher in dentate than in edentulous individuals: vitamin C, vitamin E, calcium, protein, fibre, non-heme iron, thiamin, riboflavin, niacin, pantothenic acid, and intrinsic and milk sugars.[21] Furthermore, among the subgroup of dentate individuals, mean daily intake of each of these nutrients increased with the number of teeth, as did total caloric intake.[21] This finding resembles a dose–response effect and suggests that there may be a cause-and-effect relationship between number of teeth and nutritional state. The authors also reported significant differences in blood concentration between dentate and edentulous subjects for vitamin C and vitamin A, as well as a general trend for dentate individuals to have superior intake of most nutrients.[21]

It is now recognized that physical functional impairment is associated with poor oral health in older people.[22] Not surprisingly, Mojon and others[23] found that, in elderly patients with severe functional impairment who were living in institutions, compromised oral function was associated with lower body mass index and serum albumin concentration, 2 recognized markers of malnutrition. Likewise, Krall and others[19] observed that, as impairment of natural dentition increased, intake of food sources of protein, fibre, vitamins and minerals dropped off.

A series of publications over the years have also reported compromised nutrient states in edentulous patients, many of them agreeing with the NDNS results.[21] An example was the SENECA study of 1993, conducted in 12 towns in 10 European countries and 1 town in Connecticut, in which the nutritional status of elderly people and their risk factors for malnutrition were assessed.[13] Edentulism without prosthetic replacement was associated with significantly reduced intake of carbohydrates and vitamin B_6, with a trend toward lower intake of vitamins B_1 and C, dietary fibre, calcium and iron.

In summary, lower levels of vitamin C, vitamin A and calcium are most frequently observed in edentulous individuals;[13-15,19,24] dietary fibre was reported to be inadequate in several instances,[13,23,25] as were protein[19,24] and folates.[19,24,26] These differences coincide with alterations in food intake associated with reduced masticatory function, described in the previous section. The major sources of these nutrients are fruits, vegetables, meats, nuts, seeds, dairy products, breads and cereals. As already noted, these foods are often excluded from the diet once a person experiences significant tooth loss.

Two further changes in nutrient intake brought about by the aforementioned changes in diet among edentulous individuals are an increase in percentage of total calories obtained from fat and an increase in the amount of cholesterol

consumed. Such findings have been reported by a variety of researchers, including Greksa and others,[14] Krall and others,[19] Joshipura and others[18] and Johansson and others.[16]

Although these studies provide strong evidence that tooth loss is associated with poor food intake and that people with tooth loss also exhibit compromised nutrition, they are for the most part cross-sectional studies. As a consequence, caution must be exercised in attributing the changes in nutrition to a cause-and-effect relationship.

Some studies have compared the nutrient intake of elderly people with recommended daily allowances (RDAs). However, the RDAs may, in fact, underestimate the requirements of this age group. Baxter[27] noted that bouts of injury, surgery and infectious disease can bring about upsurges in catabolism, vitamin excretion and body protein usage. Furthermore, the use of a variety of medications can affect both vitamin excretion and gastrointestinal absorption. Thus, it is possible that many elderly individuals require more than the RDA of many nutrients and that the compromised nutrition of edentulous individuals may be more important than initially thought. Some of the most significant publications on these topics are summarized in Table 1.

Resulting Health Complications

Although there are no data to support the contention that the compromised nutrition of edentulous people leads to adverse health conditions, it is known that nutrient deficiencies are associated with a variety of diseases. Therefore, it is possible that edentulous patients with poor nutrition may be at greater risk for a variety of diseases. Individuals with low consumption of vitamin A are known to be at greater risk for various forms of cancer, heart disease and rheumatoid arthritis.[28] Intake of less-than-recommended levels of vitamin E is also associated with various cancers, as well as both heart disease and Parkinson's disease.[28] Vitamin C consumption below required levels can lead to reduced immune system function and greater risks of cardiovascular disease, myocardial infarction and hypertension.[28] Low intake of thiamin can bring about nausea, constipation, appetite loss and weight loss, and can also increase the risk of heart disease.[28] Insufficient ingestion of riboflavin can augment the incidence of cataracts and arthritis, and inadequate levels of pantothenic acid can affect both nervous system function and the body's wound-healing capabilities.[28] Aside from these effects, increases in intake of fat and cholesterol have been associated with obesity and diabetes mellitus and predispose the patient to a series of cardiac conditions, including atherosclerosis, heart disease, stroke and hypertension.[28,29] In elderly people with significant loss of muscle mass and strength, a lower intake of protein could further increase frailty.[30] An extensive summary of the consequences of altered dietary intake and nutrient deficiency is provided by Willett,[31] and Suter and Russell[32] offer a useful discussion of required vitamins and minerals.

Numerous studies linking edentulism with instances of disease and medical conditions have been reported. In a cross-sectional study, Hamasha and others[33] found significant differences between edentulous and dentate individuals with respect to rates of atherosclerotic vascular disease, heart failure, ischemic heart disease and joint disease; edentulous subjects had greater prevalences of each of these illnesses. Joshipura and others[18] hypothesized that the 1-g difference in fibre intake that they observed between edentulous and dentate patients could result in a 2% difference in the risk of myocardial infarction. Such a difference is significant, given the prevalence of edentulism and the number of individuals at greater risk. Furthermore, in a recent 6-year study carried out by Shimazaki and others[34] in a large population of elderly Japanese subjects with variable dental status, the results strongly suggested that both deterioration of general health and subsequent death occur more rapidly in those with the fewest teeth. More prospective studies to monitor the survival of dentate and edentulous patients must be conducted to verify these findings. However, on the basis of these and other studies, there is certainly reason to be concerned that tooth loss and subsequent changes in diet could increase the incidence of disease among elderly people.

Improving Treatment for Edentulism

Research to advance the treatment of edentulism must also continue. Conventional dentures have long been the standard treatment for edentulism. However, even with new conventional dentures, which improve ease of chewing, dietary intake often remains unchanged.[35] Numerous studies over the past 2 decades have shown that implant-retained overdentures significantly improve ease of chewing,[36-40] and investigators are now measuring the effect of implant therapy on nutrition. Sebring and others[41] and Sandström and Lindquist[42] both conducted investigations to determine whether patients with implant-retained overdentures and conventional dentures changed their eating patterns. They found no significant alterations in dietary intake for either group, and Sebring and others[41] further noted no increase in the consumption of 27 nutrients among the implant group. Those studies suggest that, even with improvements in their ability to chew, people do not change their diets. However, Allen and McMillan[43] reported that subjects who received mandibular implant overdentures did alter their food choices, with more implant patients eating greater amounts of hard-to-chew foods, such as carrots, apples and nuts; the patients who received conventional dentures did not modify their diets. What this prospective study suggests is that appropriate oral rehabilitation can overcome the poor dietary habits of people wearing conventional dentures. Unfortunately, none

Table 1 **Summary of important articles regarding the relationship between edentulism and nutrient intake**

Reference	Study design	Study sample	Primary classification	Primary outcome	Key results
Sheiham and others 2001[21]	Cross-sectional	755 elderly adults, some living in the community and others living in institutions	Dentition status	Nutrient intake measured by food diary, blood sample and urine sample	After adjustment for age, socioeconomic factors and sex, edentulous subjects had significantly lower intake of numerous nutrients
Joshipura and others 1996[18]	Prospective, cross-sectional	49,501 male health care professionals	Dentition status	Dietary intake	Pronounced differences in intake of hard-to-chew foods between dentate and edentulous subjects; amount of processed food eaten increased with degree of edentulism
Krall and others 1998[19]	Cross-sectional	638 middle-aged and elderly men	Dentition status	Intake of various nutrients	Progressive impairment of dentition status was related to decreasing intake of calories, protein, carbohydrate, fibre and numerous vitamins and minerals; dentition status and nutrient intake were related to masticatory function
Fontijn-Tekamp and others 1996[13]	Cross-sectional	1,424 elderly men and women in 13 different towns	Dentition status	Nutrient intake	Significantly lower intake of carbohydrate, fibre, calcium, iron and vitamins B_6, B_1 and C in edentulous subjects without prosthetics
Papas and others 1998[24]	Cross-sectional	691 subjects for one portion and a subset of 181 for a second portion	Dentition status	Nutrient intake	Significantly lower intake of vitamins A, C and B_6, folates, protein and calories in men with dentures than in dentate men; intake of calcium and protein was lower in women with dentures than in dentate women
Greksa and others 1995[14]	Cross-sectional	34 edentulous and 38 dentate subjects	Dentition status	Nutrient intake determined by 24-h dietary recall	Edentulous subjects more likely to report trouble in chewing their food; diet of dentate subjects tended to be better, as indicated by lower consumption of fat and cholesterol and higher consumption of protein, vitamins and minerals
Mojon and others 1999[23]	Cross-sectional	324 older adults living in institutions	Compromised oral functional status defined by the presence of specific health disorders	Nutritional status as measured by serum albumin level and body mass index	Compromised oral functional status was associated with lower serum albumin levels and lower body mass index in functionally dependent elderly people

of these studies measured physiological variables. As-yet-unpublished data from a randomized clinical trial carried out by our group, which included blood studies and anthropometric tests, tend to support the hypothesis that nutrition improves in subjects wearing mandibular 2-implant overdentures. Further research to test the true effect of implant therapy on nutritional state is clearly a priority.

Conclusions

There is now good evidence that edentulism is associated with poor diet and compromised nutrition. Although the majority of the studies cited here have not established a cause-and-effect relationship, results from Sheiham and others,[21] Allen and McMillan[43] and our group do suggest that tooth loss may cause the dietary change. As a result, those with edentulism may be at elevated risk for a number of chronic illnesses such as cancer, diabetes, hypertension and heart disease.

Oral rehabilitation with simple mandibular implant overdentures appears to offer a solution to the lack of intake of healthy, hard-to-chew foods by people wearing conventional dentures. Additional studies must be carried out to support these recent findings. ◆

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