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Review Article

Influence of Impaired Masticatory Function on the Nutrition of Completely Edentulous Patients

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Abstract: Individuals suffering from impaired masticatory function (MF) may adapt food consistency to their existing dental status or rely on the digestive system to compensate for the lack of oral preparation of food. These circumstances further leads to deficient nutrient intake or increase the likelihood of digestive diseases and decrease gut absorption. Dysfunction of masticatory efficiency thus may be detrimental to general health. This article reviews evidence of the effects of masticatory deficiency on nutrition. It is difficult to draw conclusions from many of the reviewed studies due to issues related to study design, confounding variables, and the subjective nature of the measurements. The reviewed evidences supporting an association between MF and deficient dietary intake often are based on relatively weak correlations and cannot confer a causal relationship between the reviewed variables.
Keywords: mastication, nutrition, digestion, diet

INTRODUCTION

Loss of tooth following its removal from mouth leads to a frequent condition of deficient masticatory function (MF). Most common causes of tooth loss include caries and periodontal disease, which may result in total tooth loss causing a complete edentulism in patients. Manly and Braley [1] have reported that the prevalence of edentulism in persons aged 65 to 75 years is 16.9% in France, 24.8% in Germany, and 26% to 31% in the United States. They found that the masticatory performance and efficiency of a denture wearer is considerably less compared to that of a fully dentate individual.

Diminished MF can result in functional deficiencies of the tongue, the oral mucosa, the muscles of mastication, the salivary glands, and the nervous system. The possible effects of this impairment of MF on the general health of an individual are not fully understood and remain unclear. Individuals with impaired MF may adapt their food choices or swallow coarse particles that make the problem a digestive one. This type of behavior induce imbalance in dietary intake or may result in decreased bioavailability of nutrients and gastrointestinal disturbances in such people. In both situations, the impaired dietary or nutrient intake may increase the incidence of nutrition-deficient conditions or disease [2]. This article reviews the impact of impaired MF on nutrition and health of completely edentulous individuals.

EVALUATION OF MASTICATORY FUNCTION

Several authors [3,4] designed the different methods for evaluation of masticatory efficiency, ability, and performance. These workers suggested five different categories. The first category involves self-assessment of MF by means of scales and questionnaires. These methods are used in epidemiological surveys, where the participating individuals are asked to score their ability to chew foods into good, fairly good, or poor or to rate foods into easy, fairly easy, difficult, or very difficult to chew. Slagter and colleagues[4] advocated that this method provides very optimistic results compared to a practitioner's evaluation and requires a large sample population for survey. The second method measures the individual's ability to comminute food into smaller particles, where the chewed test food is retrieved and analyzed after mastication for a set number of strokes or set time.[3-13]The retrieved test food is then screened through sieves with a range of meshes, from which the masticatory index is calculated. Some authors also suggested the swallowing threshold test index, where the individuals are instructed to chew a standard portion of test food in as many strokes as required until they are ready to swallow it. This chewed portion of test food is then expectorated and analyze through sieving [5, 12,

14, 15]. The swallowing threshold test index is considered as an objective method as time and the number of chewing strokes are not limited and involves the natural conditions of bolus preparation. Heath [16] suggested the third method that measures the amount of sugar extracted from chewing gum. The fourth method encounters the different techniques which include bite force measurement, electromyography, kinematics, and video recording [16-20]. However, these methods demands expensive equipment and special training and need to perform in a large-scale epidemiological survey increasing its difficulties for its implication. The fifth method considers certain anatomic criteria, where each tooth is assigned a numerical coefficient according to its presumed functional importance [11, 21, 22]. These anatomical based methods encounters the teeth and neglect the role of other masticatory organs such as salivary glands, tongue, lips, cheeks and muscles of mastication.

FACTORS RESPONSIBLE FOR IMPAIRED MASTICATORY EFFICIENCY

Several authors [23-27] reported that the tooth loss leads to impairment of masticatory function. Gunne[6] studied the effect of removable partial dentures on mastication and dietary intake. He suggested that the replacement of missing teeth with removable dentures can improve mastication. Contrary to this, other authors [6, 7, 14, 28, 29] believed that such replacement cannot recover the efficiency of a dentate state. Kubota and colleagues [30] supported the degenerative changes of primary neurons following tooth extraction as one of the reason behind impaired MF. Gobel and Binck [31] also reported the similar findings in their animal studies. Appenteng and colleagues [32] investigated the intraoral mechanoreceptor activity during jaw movement in the anesthetized rabbit and found that the completed dentures often cover large areas of the oral mucosa and block part of its sensory activity. Several studies [33-36] have reported an impaired masticatory efficiency due to dysfunction of tongue motor skills and lack of tonicity of muscles involved in masticatory movements. Watanabe and colleagues[37] stressed the role of the tongue in the collection of sensory information and preparing the food bolus ready for swallowing. Liedberg and Owall [34] investigated the masticatory ability in experimentally induced xerostomia and found that such condition may negatively influence the masticatory process by making it impossible for individuals to convert food into bolus form before swallowing.

CORRELATION BETWEEN IMPAIRED MF AND DEFICIENT DIETARY INTAKE

The correlation between MF and nutrition has not been established. Experimental and longitudinal studies may not reveal this relationship due to various reasons. However, numerous authors [23, 26, 29, 38-49] have tried to correlate the impaired MF with that of inadequate food selection in edentulous people. In some western countries, the edentulous populations have a wide choice of foods. The individuals suffering from impaired MF may adapt food consistency to their existing dentate condition, which may result in an increased consumption of soft foods and a restricted consumption of hard-to-chew foods [45-49]. Several authors [45, 48, 49, 50, 51] categorized the food choice opted by an edentulous subject. Individuals with impaired MF may choose to eat industrially processed instead of natural foods. Fillion and Henry [52] reviewed the various forms of industrial food processing and concluded that in patients with impaired MF, industrial foods may favor the absorption of substantial amounts of fat and increase the eater's level of cholesterol and saturated fatty acids. In other studies [38, 39, 44, 47, 50, 53], the individuals were found to avoid hard-to-chew natural foods such as crunchy foods (raw vegetables and fresh fruits), stringy foods (meat), and dry fruits (bread or bagels) from their diet.

Renaud and colleagues [47] discussed dietary problems before and after rehabilitation of the MF in edentulous subjects. They observed that soft fruits (raspberries, strawberries, grapes, and tomatoes) may be avoided by denture wearers because their seeds often lodge under prostheses. Some authors [54, 55] reported that denture wearers may choose home processing to soften foods, which may alter the nutritional value of foods due to long cooking times. This causes degradation of essential micronutrients such as vitamin C, thiamin, and folates and reduces the expected bioavailability of these nutrients in the ingested food. Home processing of foods may also produce trans-fatty acids [52]. Krall and colleagues [51] compared the dietary intake in complete denture wearers and dentate subjects and found that the protein and dietary fiber intake in former group was 15% and 24% lower, respectively, than that of later group. They also observed a decrease of 20%, 35%, and 27% in the intake levels of folic acid, carotene, and iron, respectively. Other authors [50, 56, 57] reported a significant decrease in the intake of vitamins C, A, B1, B2, and B12, folic acid, and essential minerals such as calcium and iron in complete denture wearers. Joshipura and colleagues [50] surveyed more than 49,000 dentate and edentulous male health care professionals and observed that the mean differences in the intake of 10 different nutrients ranged from 2% to 13%. In partially edentulous subjects the decrease in nutrient intake was proportional to the number of missing teeth.

Hamada and colleagues [58] carried a randomized clinical trial comparing the efficacy of mandibular implant-supported overdentures and conventional dentures in diabetic patients and failed to demonstrate substantial changes in patient nutrient intake after an improvement in dental status. Authors related the bad dietary habits as the causative factor rather than the poor dental status. Horwath [41]

suggested that some studies assessed MF on the basis of questionnaire which could not reflect the reality of dental arch efficiency. Overall a weak correlation between MF and dietary intake has been reported and needs the future sound scientific studies to reveal any potential relationship.

IMPAIRED MF AND RESULTING NUTRITIONAL CONSEQUENCES

Some workers [33, 42] carried experiments in animals like rats and pigs and observed that mastication exhibits a moderate influence on the digestion of foods. Kapur and Okubo [59] reported the similar findings in rats and claimed a more evident influence of impaired MF on the digestion of foods in old than in young rats. Geissler [42] found that minced meat is at best poorly digested by dogs but meat is completely digested when swallowed in large lumps. These findings suggest that the conclusions drawn from animal and human studies varied. Hence, species differences should be considered in this area of research. Prinz and Lucas [15] experimented mixtures of solid and liquid food in various proportions in human mastication and reported that swallowing threshold is related to both particle size and degree of moistening. Several authors [60, 61] studied the absorption of whole peanuts, peanut oil, peanut butter and cereal food and observed that insufficient mastication of these foods remained intact in the feces. Rodriguez-Olleros and Rey [62] reported gastritis and ulcers in subjects with impaired MF. Hedde and colleagues [63] carried animal (swine) experiments and concluded that the results appeared to be dependent on the species. Swines do not exhibit the problems similar to those of humans. Brodeur and colleagues [44] suggested the correlation between masticatory efficiency and gastrointestinal disturbances, as expressed by the presence of symptoms such as diarrhea and constipation is mostly seen in the elderly.

EFFECT OF IMPAIRED DIETARY INTAKE ON VARIOUS DISEASE RISKS

Several studies [64-69] have reported correlation between poor oral health and general health. Many micronutrients and macronutrients provide protection against various types of diseases, and the excessive consumption of some nutrients may be harmful to health. Several epidemiologic investigations [70-78] conducted in various countries have found that intake of vegetables and fruits (raw carrots, pears, and apples) can lower the prevalence of cancer at many sites. Block and colleagues [74] reviewed the epidemiological evidence of fruits and vegetables in prevention of cancer involving lung, colon, cervix, esophagus, oral cavity, stomach, bladder, pancreas or ovary. They reviewed around 156 articles, out of which 128 concluded that fruit and vegetable consumption had a significantly protective effect. Scheppach and colleagues [77] suggested the existence of many potential anticarcinogenic agents in vegetables and fruits. The authors suggested the possible mechanism behind anticarcinogenic potential occurring via an inhibition of nitrosamine formation, antioxidant effects, provision of substrates for formation of antineoplastic agents, and dilution and binding of carcinogens. The dietary fiber decreases the colorectal cancer mortality by binding bile acids, lowering acidity, and increasing fecal bulk [78]. Schneeman [79] reported the active role of dietary fiber in facilitating gastrointestinal transit, lowering plasma cholesterol levels, reducing the glycemic response to carbohydrate-containing meals. Jenkins and colleagues [80] has recommended the consumption of dietary fiber for the prevention of Crohn's disease, constipation, irritable bowel syndrome, diverticular disease, and gallstones. Werler and colleagues [81] reported that low consumption of vitamin C has been inversely associated with cataracts and slow healing after injury. A daily periconceptional consumption of folic acid by women may lower the risk of neonatal neural tube defects. Several authors [82-84] reported the potential role of saturated fatty acids in developing atherosclerosis. Increased cholesterol and saturated fatty acid consumption increases the risk of cardiovascular diseases especially myocardial infarction. Some studies [85, 86] revealed the role of a fatty diet in increasing the risk of hypertension, cardiovascular diseases and noninsulin-dependent diabetes. Thus, impaired MF could be considered as indirect risk factor for the etiology of cardiovascular diseases.

CONCLUSION

A compromised oral health causes an impairment of MF, which further may lead to inadequate choice of foods altering nutrient consumption. This suggests that a dysfunction in masticatory efficiency is correlated with the disturbances into general health of an edentulous individual. A significant correlation between a poor oral health and some gastrointestinal diseases has been established. Public health services must be given stress on the need for preserving natural teeth to enable adequate nutritional consumption, and dental practitioners should be aware of various nutritional risks associated with denture wearing.

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