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Secondary Endpoint of the Prosthodontics

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Abstract

Traditional primary end point of the prosthodontics has been to restore and reshaping of oral functions. The secondary endpoint of prosthodontic treatment is to maintain improved chewing function based on the objective evaluation of oral function and to evaluate metabolism, body composition and prevention of odontogenic bacteremia. Present article provides an overview of the candidate of secondary endpoint and recent advances of the primary endpoint of prosthodontic treatment.

Our purpose of this article was to provide valuable information to achieve the secondary endpoint of the prosthodontic treatment. Consequently the previous studies which investigated or reviewed oral function and rehabilitation, and oral bacteria- or nutrition-related systemic diseases were included.

Chewing ability is one of the most important dimensions not only of oral health but also of general health, because the ability to chew food may affect dietary choices and nutritional intake. However, there is a risk that improvement of mastication efficiency leads to the dietary excess. Therefore, importance of the evaluation of oral function and occlusal rehabilitation, and role of prosthodontics on the nutrition and the overall health were discussed. In addition, this article described oral bacteria- and non communicable diseases, and provides basic knowledge of the nutrition for oral health.

In conclusion, prosthodontic treatment should improve not only oral functions, but subsequently overall health. Therefore, dentist should aware not only of the primary endpoint but secondary endpoint.

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Introduction

The main goal of the dental medicine is the increment of health span and improvement of QOL through oral health. Prosthodontics is defined that the dental specialty that deals with the diagnosis, treatment planning, rehabilitation and maintenance of the oral function, comfort, appearance and health of these patients [1]. Traditional primary end point of the prosthodontics is restore and reshaping of oral functions. The accumulated knowledge of prosthodontics makes it feasible that the precise evaluation of the oral functions based on the mandibular movement and occlusion and the more suitable dental materials for prosthodontic treatments have been developed. As a result, more sophisticated prosthesis can be created. However prosthodontists rely more on art and experience than science to diagnose oral problem and to decide on a treatment planning. Evaluation of oral function is fundamental for treatment success in prosthodontics and various objective methods for measuring oral function were reported in previous studies, nevertheless there have been a very few reports of the objective measurement and comprehensive assessment during complete feeding sequences from ingestion to final swallow in the clinical setting. Not surprisingly, objective evaluation results of oral functions in patient's cannot be taken into account in the design of dental prostheses.

Meanwhile, with the advances of the research for the oral health and systemic disorders, the oral health affected on the systemic disorders especially noncommunicable diseases. At earlier stage, it had been proposed that periodontal diseaseaffect on the coronary heart disease[2-6], low birthweight [7-10] and obesity [11-13]. Recently, evidences that periodontal bacteria, especially Porphyromonas gingivalis,are the causative bacteria of the rheumatoid arthritis [14-16]or Alzheimer's disease [17-20] have been accumulated. The mechanisms of these co-relations are perinatal bacteria and their pathogenic products invade into the blood vessels and ail distant organs. Thus, bacteremia is the essential context of the co-relation oral health and systemic diseases.

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Recent main goal of the prosthodontic treatment is restore the masticatory function, however, in some cases, without taking into account a harmony among oral functions, longevity and esthetics, the decided treatment planning may not lead to an expected longevity of prosthodontic treatment, and without nutritional instruction, improved masticatory function may lead to foster malnutrition such as excess intake high-glycemic-index diet. To improve the mastication efficiency is not objective, its only means. Final goal of the prosthodontics is improve the overall health by improving nutrition status, metabolic disorders, and body composition. The secondary endpoint of prosthodontic treatment isto maintain improved chewing function based on the objective evaluation of oral function and to evaluate metabolism, body composition and prevention of odontogenic bacteremia. Therefore, dentist should aware that

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prosthodontic treatment leads to the improvement over all health through the appropriate dental treatment based on the objective assessment and diagnosis.

Present article provide an overview of the candidate of secondary endpoint and recent advances of the primary endpoint of prosthodontic treatment.

Objective Evaluation of Chewing Ability

Patient's satisfaction in prosthodontics treatment depends on factors such as chewing ability, stability, comfort (fit), esthetics, taste and speech [21]. Chewing ability is one of the most important dimensions not only of oral health but also of general health, because the ability to chew food may affect dietary choices and nutritional intake [22]. Feine and Lund reviewed methods commonly used to measure the chewing ability of patients wearing conventional and implant prostheses and demonstrated that patient-based outcomes were recommended as the most appropriate variables of chewing efficacy [23,24]. Many subjective and objective methods to assess chewing ability have been used in the previous studies, and evaluations of prosthodontic treatments have relied largely on subjective evaluations of patients in the clinical setting [23]. However, because studies that use the subjective method lack the necessary objectivity for repeatability and validity [25], it is still desired to develop an objective evaluation method of chewing ability [24].

Satsuma et al. [26] and Shigemotoet al. [27] have developed the synchronized recording system of various bio-information including jaw movement, EMG activities, swallow sounds, respiration, and video image of swallowed food bolus during a complete sequence of chewing. Shigemoto et al. [27] conducted preliminary recordings during the chewing sequence of a piece of bread (2 x 2 x 2 cm) in healthy two male adult volunteers (67 and 45 years) using the developed system in order to record and analyze the bio-informations. They observed that a bolus of bread reached the pharynx prior to swallow onset (process model of feeding) and that there were differences between total duration and number of chewing cycle of the sequence of chewing in both volunteers. In only 67-year volunteer, the swallowing occurred during chewing was observed. They concluded that recording and analyzing of the bio-informations during the sequence of chewing may be useful for the evaluation of chewing ability.

The choice and outcome of the treatment plan currently depends on the knowledge, skill and experience of the clinician [24,28].The most important thing for oral health is to maintain oral function in terms of biting, chewing, smiling, speaking, and psychosocial wellbeing [29]. Therefore, the objective chewing evaluation such as above can be indispensable to achieve an expected longevity of prothodontic treatment.

Occlusal Rehabilitation Based on Patient's Masticatory Function

Various factors such as vertical dimension of occlusion (VDO), centric relation, occlusal contact pattern, esthetics and phonetics need to be considered during occlusal rehabilitation [28].In terms of VDO, the practitioner is still placed in a situation with more or less hazardous decisions based on the clinical experience [30]. It is quite important to have proper tools to verify that the VDO will be in harmony with all the anatomical and neuro-physiological determinants, and to objectively determine to increase or decrease VDO [30]. Furthermore, although many centric relation (CR) registration techniques were developed, there is no established "gold standard" method of recording patients' CR [31].

Recently, Shigemoto et al. introduced an approach to determination of the CR based on analyzing of jaw movement in 6DOF [M]. They studied the kinematic axis (KA) that kinematically estimated from sagittal border jaw movement of 45 dentate subjects, and conducted asimulation study to investigate the effect of exclusion range of jaw movement data from the intercuspal position (ICP) on estimation of the KA. They found that the incomplete sagittal border jaw movement data set does not include data points inside a 7 mm distance from the ICP can be used for estimation of the KA [32]. In other words, in mouth opening less than 7 mm, mainly rotation of mandible occurs around the KA and the therapeutic VDO can be determined objectively. This result may lead to the development of method for designing of dental prostheses that harmonize with the patient's oral function.

The virtual reality technology has opened door for dental professionals towards successful diagnosis and treatment planning with virtual articulator in day to day clinical practice [33]. However, because the virtual articulator requires digital 3D representations of the jaws and patient specific data on jaw movement [33], the proper VDO, CR, position of occlusal plane, and inclination and area of occlusal facet must be transferred to the virtual articulator system as numeric data to achieve successful diagnosis and treatment planning.

Oral Diseases and Noncommunicable Diseases

The treatment of prosthodontics is to fill up the missing teeth and it should be result in the improvement of oral functions. Therefore, mastication efficiencies, pronunciation and aestheticity can be the primary end point of the prosthodontic treatment. However, there is a risk that improvement of mastication efficiency leads to the dietary excess. Even after improvement of mastication efficiency, if the improper nutrition intakes remain, health cannot be achieved. The main goal of the dental medicine is the increment of health span and improvement of QOL through oral health. Therefore, after prosthodontic treatment, subsequent overall health direction is indispensable, especially for the nutrition intake. Figure 1 shows the relation of oral disease and noncommunicable diseases. Gobbling is the risk factor of the obesity and diabetes. Deficiencies of vitamins, minerals and dietary fibers and excessive intake of carbohydrates and high-glycemic-index diet are the risk factors of the osteoporosis [34,35], obesity and diabetes [36,37]. Figure 2 shows one of the examples of the health instructions after prosthodontic treatment. Intervention of the health direction is evaluated by the body composition and basal metabolism.

The Food Frequency Questionnaire (FFQ) is the most common dietary assessment tool used in large epidemiologic studies of diet and health [38,39]. The self-administered FFQ booklet asks patients to report the frequency of consumption of approximately 125 line of food. Caloric Intake and PFC (protein, fat, carbohydrates) ratio can be calculated by commercially available soft wear. Ideal value of caloric intake is 2,500 kcal per day for adult male and 2,200 kcal for adult female. Ideal value of each nutrient for Japanese is 20 to 25% for protein, 20-25% for fat and 50 to 60% for carbohydrate for Japanese people. These indexes have international variations.

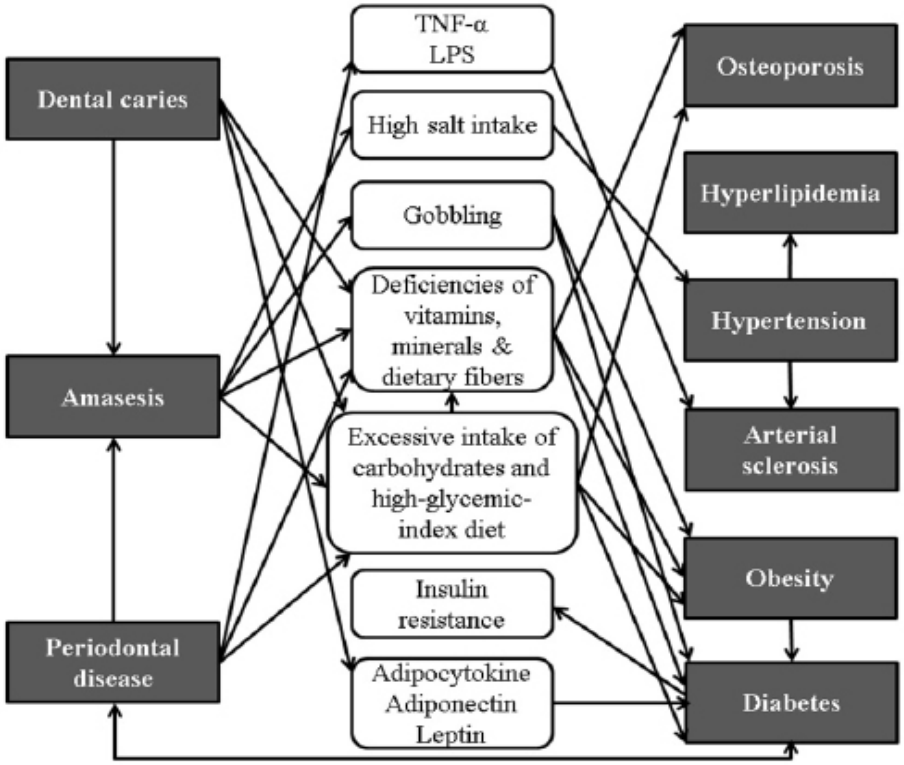

Figure1: Relation of oral disease and noncommunicable diseases.

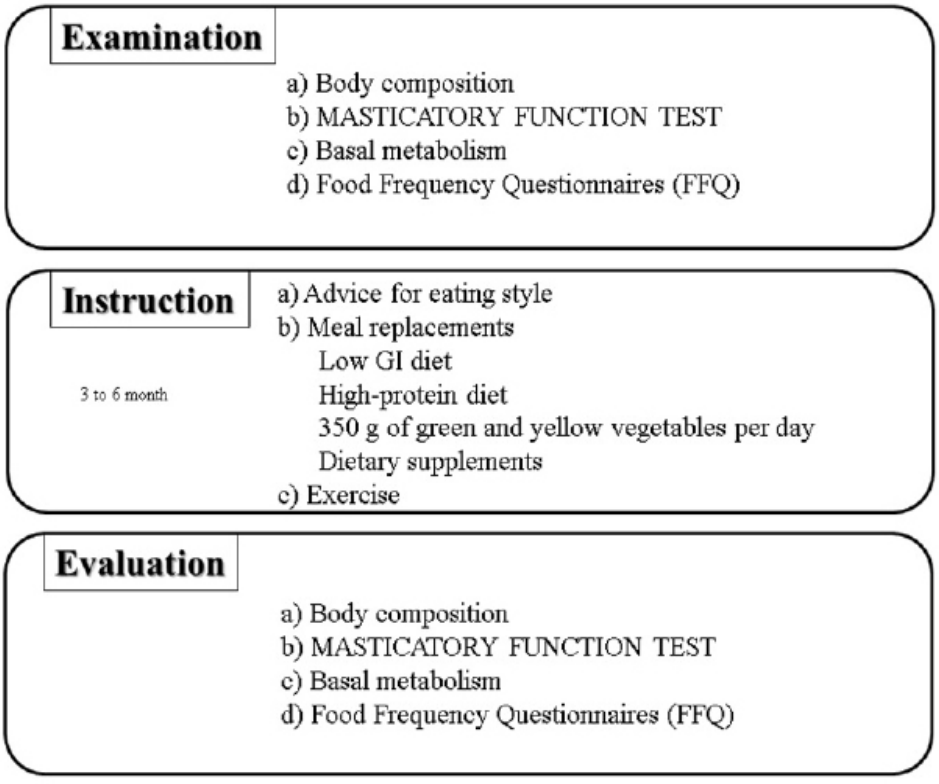

Figure 2: Examples of the health instructions after prosthodontic treatment.

Overweight and obese individuals are at an increased risk for many diseases and health conditions, including Hypertension, Dyslipidemia, Type 2 diabetes, Coronary heart disease, Stroke, Gallbladder disease, Osteoarthritis [40] and cancers (including endometrial, breast, and colon) [41]. Body mass index (BMI) is a well known index and it reflects visceral fat. It is a very simple index and it can measure without special devices. Monitoring the changes of BMI after prosthodontic treatment is important. After prosthodontic treatments, if a patient with overweight or obese increase BMI, risks for other diseases may increase. In such a case, instruction of meal replacements including recommendation of low-glycemic-index diet, and exercise is indispensable. While patients with underweight regarded as malnutrition, eating disorder, or other health problems should be increase the BMI by nutritionally balanced diet. Waist circumstance shows the closer co-relation with the amount of visceral fat than BMI [42-44]. To check the waist circumstance additionally is more suitable. Body composition monitor measures fitness indicators: body weight, BMI, body fat percentage, visceral fat, skeletal muscle, and resting metabolism etc. With this device, more precise monitoring is feasible.

Basic Knowledge of the Nutrition for Oral Health

The presence, number and distribution of natural teeth are related to the ability to eat certain foods, affecting nutrient intakes and two biochemical measures of nutritional status. About one in five dentate (with natural teeth) free-living people had difficulty eating raw carrots, apples, well-done steak or nuts. Foods such as nuts, apples and raw carrots could not be eaten easily by over half edentate (without natural teeth but with dentures) people in institutions. In free-living, intakes of most nutrients and fruit and vegetables were significantly lower in edentate than dentate. Perceived chewing ability increased with increasing number of teeth. Daily intake of non-starch polysaccharides, protein, calcium, non-haem iron, niacin, vitamin C and intrinsic and milk sugars were significantly lower in edentate. Plasma ascorbate and retinol were significantly lower in the edentate than dentate. Plasma ascorbate was significantly related to the number of teeth and posterior contacting pairs of teeth [45].

For the prevention of the dental disease, two major administrations are necessary. One is the control of oral bacteria. By brushing or other oral hygiene method, to keep well oral hygiene status leaded to the control of oral bacteria which is the agents of bacteremia described below. The other is administration of diet.

The keys diagram is well known etiology of the dental caries. The major environmental factor of the dental caries is dietary sugar. Stagnation of food on the deletion is one of the risk factors of the dental cares. It means that3major nutrients biased to the carbohydrate. In a sense, unbalanced nutrition reflects on the dental caries and periodontal disease. Following section, recommended food and nutrient with salutary effects are described.

Tea

Tea contains Fluoride from 0.32 to1.69ppm and Polyphenol. It also contains several antimirobes. Especially, epigallocatechin gallate inhibits synthesis of the cell wall of the periodontal bacteria[46] and acid production of mutans streptococci [47-48].

Milk and dairy product

By the cohort study and statistical modeling, dietary calcium intake, particularly calcium from dairy products, protect against loss of teeth in adult men(incidence-rate ratio 0.32, 95% confidence interval 0.15-0.68) and women(incidence-rate ratio 0.25, 95% confidence interval 0.09-0.73)[49]. By the cohort study of 20,366 Japanese dentists, the mean intakes of milk and dairy products decreased with the increasing number of teeth lost [50]. Intake of Milk and dairy product were negatively associated with the number of root caries events during the 6 years in elderly population [51]. Rehardening effects on softening of human enamel following milk exposures were evident by SEM analysis in situ [52].

Dietary antioxidants

A higher intake of dietary antioxidants (vitamin C, vitamin E, α-carotene and β-carotene) was inversely associated with the number of teeth with periodontal disease progression in community-dwelling older Japanese [53].

Fruits, Vegetables and whole-grain cereal

Fruits, Vegetables and whole-grain cereal are rich in dietary antioxidants. Green tea, coffee and red wine are also important supplier of the dietary antioxidants. Peanuts almond and sunflower seed is the supplier of the vitamin E. An inadequate dentition was associated with lower consumption of a range of fruits and vegetables (peach, nectarine, plum, apricot, grapes or berries, vegetables, sweet corn, mushrooms, lettuce and soy beans) among Australian adults [54].

Vitamin D

Vitamin D might be a protective factor for tooth loss. 10-μg/L increase of serum 25OHD was associated with a 13% decreased risk of tooth loss and no significant association was found between serum 25OHD and caries progression [55]. Total vitamin D intake ≥ 800 IU was associated with lower odds of severe periodontal disease (OR = 0.67, 95% CI = 0.55-0.81) and moderate-to-severe Alveolar bone loss (OR = 0.54, 95% CI = 0.30-0.96) relative to intake < 400 IU/day. Vitamin D intake may protect against periodontal disease progression [56].

Saturated fatty acid

ω-3 fatty acids (FAs),Low DHA intake was significantly associated with more periodontal disease events in older people. Higher dietary intakes of DHA and, to a lesser degree, EPA, were associated with lower prevalence of periodontitis [57].

Bacteremia

Many evidences have been accumulated on the bacteraemia of oral origin linked to several systemic diseases. Bacteraemia of oral origin so called odontogenic bacteraemia is defined as presence of viable oral bacteria in the bloodstream following dental procedures or everyday oral activities [58]. Routine oral hygiene activities such as brushing, flossing, and other physiological phenomena, such as chewing, can be assumed to be disruptive to the delicate anatomical and functional barrier between the oral biofilm and the host tissues. Any disruption of bacterial biofilm within the gingival tissue niche leads to dissemination of bacteria into the bloodstream [59, 60]. Total surface area of the ulcerated periodontal pocket epithelium in subjects with sever periodontitis is equivalent to large ulcer, the size of which is measures 15-20cm^2 [61]. Even the healthy subjects for the periodontitis have 0.3cm^2 ulcers [62]. From these ulcers oral

pathogenic bacteria can easily invaded to the periodontal tissue, and subsequently blood stream.

These invaded bacteria in bloodstream results in source of thrombus or arterial sclerosis [63]. Standardized guidelines concerning infective endocarditis [64-67] emphasis the cause of infective endocarditis has been shifted from dental procedure-related bacteraemia to cumulative bacteraemia due to everyday oral activities. NICE (National Institute for Health and Clinical Excellence) guideline [66] proposed that it was "biologically implausible" that a dental procedure would lead to a greater risk of infective endocarditis than regular tooth brushing. In the UK, NICE recommended complete cessation of antibiotic prophylaxis for prevention of infective endocarditis in March, 2008. Roughly, 90% of the prescriptions were issued by dentist. By March, 2013, 35 more cases per month were reported than would have been expected had the previous trend continued. This increase in the incidence of infective endocarditis was significant for both individuals at high risk of infective endocarditis and those at lower risk [68]. Routine oral hygiene activities and physiological phenomena assumed to be latent greater risk under the presence of inflammation in situations such as periodontitis, gingivitis, pulpal or root canal infections, or oral trauma by poorly fabricated dentures.

According to the clinical practice guideline with a systematic review approved by the American Academy of Orthopaedic Surgeons and by the American Dental Association, Median incidence rates of bacteremia approximately 5% for chewing 15% for tooth brushing [69]. Therefore, the prevention of bacteremia is important to prevent the exposure of the risks for other diseases. Additionally, several studies revealed that periodontal treatment leaded to the betterment of parameters employed to assess the endothelial functions [70]. To prevent invasion of bacteria into the bloodstream from gingivitis is important. However, monitoring bacteremia is not easy. It can be done only by hemoculture. The evaluation of bacteremia can be approached to checking the bleeding form oral cavity as a surrogate end point. To check bleeding form oral cavity, salivary levels of hemoglobin is useful [71-73]. Strip method based on immunochromatography is commercially available [74,75]. In Japan, two reagents measuring salivary levels of hemoglobin are approved by pharmaceutical affairs law. Therefore, salivary levels of hemoglobin can be the secondary end point after prosthodontic treatment.

Conclusion

Prosthodontic treatment should improve not only oral functions, but subsequently overall health. Therefore, dentist should aware not only of the primary endpoint but secondary endpoint.

Competing Interests

The authors declare that they have no competing interests.

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