Relationships between changes of posterior occlusal support status and risk for protein-energy malnutrition among the Japanese community-dwelling elderly

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Abstract

Objectives: Protein-energy malnutrition (PEM) among elderly is a risky state, which leads to limited activities of daily life and a bedridden state. Oral health status in elderly can be one of the indicators to occur PEM. The purpose of this study was to assess the correlation changes of posterior occlusal support status and incidence of PEM over 5 years in the Japanese community-dwelling elderly.

Methods: Two hundred and seventy-two subjects aged 75-year-old in 2003 were followed up in 2008. Posterior occlusal support without denture in 2003 and 2008 were categorized into one of three groups based on the number of occlusal support zone (OSZ). According to the concept of Eichner's Index and changes of them over 5 years, five groups for the main exposure variables were defined as 1) Complete: remain four OSZ, 2) Moderate: remain one to three OSZ, 3) Lost support: remain no OSZ, 4) Early change: change from four to one to three OSZ and 5) Late change: change from one to three to no OSZ. For the outcome variables, rates of changes in protein intake, total energy intake and BMI over 5 years were calculated and divided into two groups. Additionally, nutrition status for malnutrition criteria were defined: A) IPE; rates of changes in protein intake and total energy intake were less than or equal median and B) IPEB; rates of changes in three items were less than or equal median.

Results: Male subjects whose the number of posterior OSZ decreased from four to one to three over 5 years had significantly higher risk in IPE and IPEB compared with those in another groups (odds ratio: 4.0 for IPE and 4.3 for IPEB).

Conclusion: Male elderly who lost the number of posterior occlusal support zone declined protein intake and increased risk for PEM.

Keywords: Malnutrition; Protein-energy malnutrition; Occlusal support zone; Elderly

Abbreviations: PEM: Protein-Energy Malnutrition;

POSS: Posterior Occlusal Support Status; OSZ: Occlusal Support Zone; ADL: Activity of Daily Living; TMIG: Tokyo Metropolitan Institute of Gerontology; BMI: Body Mass Index; BDHQ: Brief-type self- administered Diet History Questionnaire; IPE: Insufficient of Protein and Energy; IPEB: Insufficient of Protein, Energy and BMI; ANOVA: Analysis Of Variance

Introduction

Malnutrition is a serious problem for elderly and related to prolonged length of stay in hospital [1, 2], increase risk of falls [1], decrease physical function [2] and poorer quality of life [2]. The prevalence of nutritional problems especially PEM has been the rising with 1-15 % of outpatients and 15-60 % of institutionalized elderly [3]. Agarwal E, et al. reported that obtaining food stage, ingestion stage and digestion and absorption stage were three stages of food consumption, and oral health problems such as missing teeth and ill-fitting dentures were the factors affecting ingestion stage [4]. Previous studies evaluated the relationship between oral health problems and nutrition intake by the number of remaining teeth and missing teeth [5-8], chewing function [9], periodontal disease [10] and occlusal status [11-15]. Kazuya M reported that related factors of malnutrition for elderly were aging effects, social factors, psychological factors and disease factors [16]. Thus, POSS could affect nutrition intake leading to malnutrition. Moreover, most of the studies indicated the only relationships between POSS and malnutrition, which have not been clarified the causality by changes of POSS on nutrition intake. Accordingly, this study was aimed to assess association between changes of POSS and malnutrition for 5 years among Japanese community-dwelling elderly.

Methods

The target population for this study was drawn from the Niigata study between 2003 and 2008. The Niigata cohort study was a community-based study initiated in 1998 to assess relationship between general health and oral health. Initially, questionnaires were sent to all 4542 Niigata citizens aged 70 years to inform of the purpose and request to participate in this study. The positive response rate was 81.4% (n= 3695). Six hundred individuals (screened population) were selected randomly to have approximately same number of male and female. They agreed to undergo medical and dental examination, and signed consent forms regarding the protocol. This protocol was reviewed and approved by the Ethics Committee of the Faculty of Dentistry, Niigata University. In 2003, five years after the Niigata study was initiated, dental and medical examination, dietary assessment and questionnaire survey were conducted for participants as baseline. In 2008, at the follow-up survey, same examinations were conducted. The subjects who participated in both baseline and follow-up were considered for data analysis.

Dental examination

The dental examination was conducted at baseline and follow-up by four calibrated dentists. According to the records of dental examinations, POSS without denture in baseline and follow-up was categorized into one of three groups based on the number of occlusal support zone (OSZ) according to the concept of Eichner's Index which consisted of occlusal contacts of the existing natural teeth or fixed prostheses in the premolar and molar regions [12, 17, 18]. The POSS criteria for the subjects were as follows:

(i) Group A (four OSZ: Eichner A1, A2 and A3)

(ii) Group B (one to three OSZ: B1, B2 and B3)

(iii) Group C (no OSZ: B4, C1, C2 and C3)

Medical examination

Blood samples at baseline and follow-up were collected. The serum albumin level was measured by the bromocresol green method.

Questionnaire and anthropometric evaluations

Questionnaire survey regarding participants' medical history (diabetes mellitus, hypertension, and renal disease), education and ADL was conducted at baseline and follow-up. ADL was assessed using the TMIG Index of Competence: TMIG index. Anthropometric evaluations included measurements of weight and height to calculate BMI.

Dietary assessment

The dietary assessment was conducted at baseline and follow-up using a BDHQ. BDHQ was developed for the general Japanese population, and its validity was tested and reported elsewhere [19, 20]. Daily intake of protein, total energy and food groups were estimated from this BDHQ.

Description of main exposure variable

Changes of POSS between baseline and follow-up were categorized into five groups based on its score in each year. These groups were used to specify the main exposure variables. Grouping by POSS changes were as follows:

(i) Complete (remain Group A)

(ii) Early change (Group A at baseline, but Group B at follow-up)

(iii) Moderate (remain Group B)

(iv) Late change (Group B at baseline, but Group C at follow-up)

(v) Lost support (remain Group C)

We defined the stages which were from (i) Complete to (ii) Early change as Early lost stage and (iii) Moderate to (iv) Late change as Late lost stage.

Description of outcome variables

Rates of changes (%) in protein intake, total energy intake and BMI over 5 years were calculated for the outcome variables. The calculation method was as follows: Rates of changes (%) = each variable at the follow-up divided by each variables at the baseline multiplied by 100.

Each median was cut off and outcome variables were divided into two groups. Protein intake was adjusted for the total energy intake using residual method. Grouping by our criteria were as follows:

(i) Sufficient (rates of changes in each outcome variables were more than each median)

(ii) Insufficient (rates of changes in each outcome variables were less than or equal to each median)

We defined additional nutrition status for malnutrition evaluation as follows:

(i) Insufficient in rates of changes in both of protein intake and total energy intake for outcome variables were defined as IPE.

(ii) Insufficient in rates of changes in all of three items (protein intake, total energy intake and BMI) for the outcome variables were defined as IPEB.

Statistical analyses

Characteristics at the baseline between male and female were compared with paired-t test and chi-square test. Intake of protein and total energy, BMI and serum albumin level in each change of POSS at baseline and follow-up were compared with ANOVA. Each change of POSS and outcome variables between Complete and Early change groups and between Moderate and Late change groups were compared with chi-squared test. Multivariable logistic regression analysis were used to

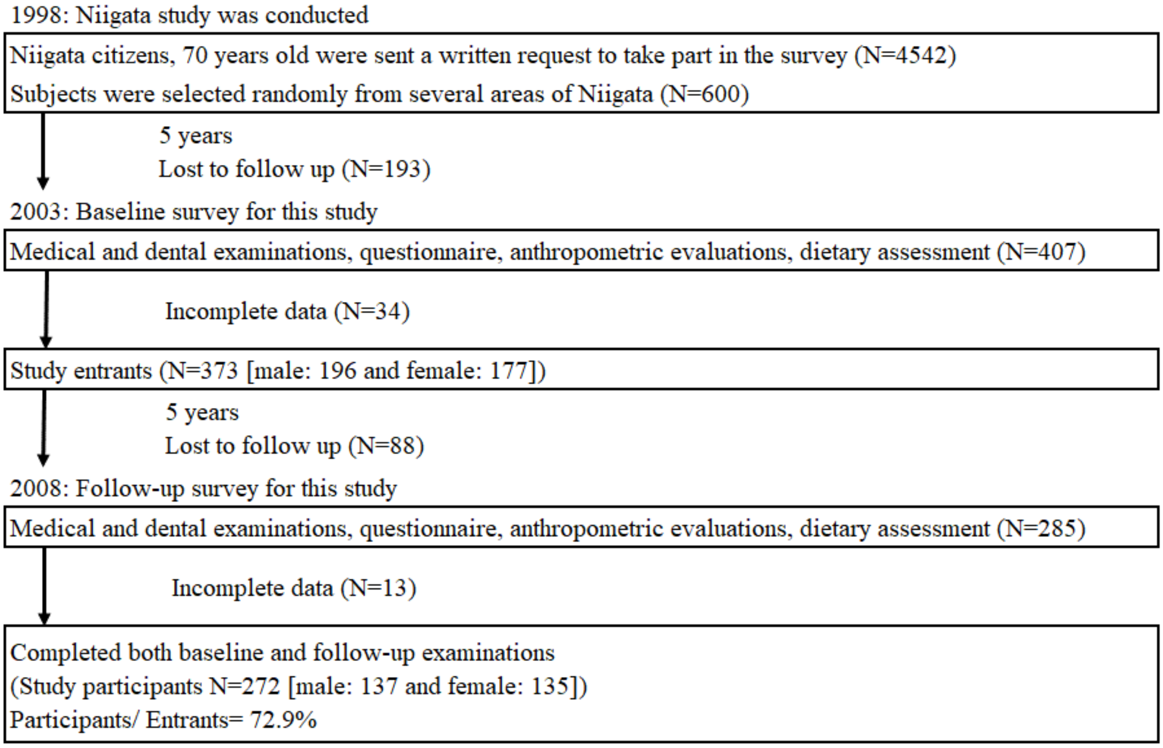

Fig. 1 Overview of recruitment of participants for this study.

examine the odds ratio of IPE and IPEB in Early change group after adjustment for education (categories: years of schooling ≥ or < 9 years), difference of ADL (TMIG index: continuous) and medical history (diabetes mellitus, hypertension and renal disease; categories: Yes or No at follow-up). An $\alpha = 0.05$ level was considered statistically significant for all analyses. All calculations and statistical analyses were performed using the statistical software package STATA (version 13; Stata Corp., TX, USA).

Results

Among 600 original participants of Niigata study, 193 individuals could not participate in the baseline assessment in 2003 due to the following reasons (refused, institutionalized, died and moved out of Niigata city). During baseline examinations, 34 individuals did not submit complete data in dental examinations, questionnaire, anthropometric evaluations and dietary assessment data and excluded, and 373 individuals were left to enter the study. Five years later, follow up assessment was conducted and 88 individuals could not participate (refused, institutionalized, died and moved out of Niigata city). Among participants who were in follow up examinations, 13 individuals did not submit complete data in dental examinations, questionnaire, anthropometric evaluations and dietary assessment, and excluded. Finally 272 individuals were included in the final analyses (Fig1).

Table 1 presented the baseline characteristics of the subjects. Though there were no differences between male and female in the prevalence of each POSS category, however significant differences between male and female in protein intake, total energy intake, BMI and serum albumin level were detected.

Table 2 presented the means of intake of protein and total energy, BMI and serum albumin level in each

Table 1. Baseline characteristics of the subjects (Mean ± SD, or N (%))

Variable		Male	Female	p-value
Number of subjects		137	135	
Age		75		
Number of remaining teeth		16.6 ± 9.51	16.3 ± 8.69	0.759$
Protein (g/day)		77.2 ± 12.6	69.2 ± 11.4	0.0001$
Total energy (kcal/day)		2386.7 ± 583.5	1969.7 ± 579.1	0.0001$
BMI		22.7 ± 2.72	23.5 ± 3.15	0.042$
Serum albumin (g/dL)		4.07 ± 0.232	4.19 ± 0.219	0.0001$
TMIG index		12.0 ± 1.16	12.2 ± 1.16	0.184$
History of diabetes mellitus		10 (38.5)	16 (61.5)	0.201#
History of hypertension		49 (51.6)	46 (48.4)	0.770#
History of renal disease		3 (75)	1 (25)	0.321#
The number of each category of POSS				
	Group A	49(58.3)	35(41.7)	0.082#
	Group B	36(41.4)	51(58.6)	
	Group C	52(51.5)	49(48.5)	

$: t-test.

#: chi-square test.

Table 2. Intake of protein and total energy, BMI and serum albumin in each occlusal change groups at baseline (Mean±S.D.)

	N	Protein (g/day)	p-value*	Total energy (kcal/day)	p-value*	BMI	p-value*	Serum albumin (g/dL)	p-value*
Male									
Complete	39	78.5±11.5	N.S.	2382.6±554.5	N.S.	23.4±2.5	N.S.	4.1±0.3	N.S.
Early change	10	70.3±6.0		2345.1±486.4		22.5±3.3		4.0±0.2	
Moderate	31	78.9±12.0		2272.3±412.2		22.9±2.6		4.1±0.2	
Late change	5	76.4±4.9		2478.7±458.8		22.8±0.7		4.1±0.3	
Lost support	52	76.5±14.7		2457.1±711.6		22.2±2.9		4.1±0.2	
Female									
Complete	31	72.4±9.2	N.S.	2063.5±500.1	N.S.	22.8±3.0	N.S.	4.2±0.2	N.S.
Early change	4	61.4±8.5		1649.2±304.7		24.3±2.2		4.1±0.1	
Moderate	41	69.3±12.2		1995.0±618.5		23.1±3.1		4.2±0.2	
Late change	10	64.1±6.5		1868.5±513.3		23.9±2.3		4.2±0.3	
Lost support	49	68.7±12.4		1936.0±622.9		24.1±3.5		4.2±0.2	

*: ANOVA

N.S.: Not significant

change of POSS at baseline. There were no significant differences between each occlusal group.

Table 3 presented the results of associations between the occlusal change groups and protein intake, total energy intake, BMI, IPE and IPEB in each stage. The proportions of male Early change group with IPEB were

Table 3. Association between the changes of POSS and insufficient of protein intake, total energy intake and BMI and IPE and IPEB

Stage of POSS changes	N	Protein		Total energy		BMI		IPE[$]		IPEB[#]	
		Insufficient N (%)	p-value*	Insufficient N (%)	p-value*	Insufficient N (%)	p-value*	Insufficient N (%)	p-value*	Insufficient N (%)	p-value*
Male											
Complete	39	13 (33.3)	**0.035**	18 (46.2)	0.056	21 (53.8)	0.727	7(17.9)	**0.007**	5 (12.8)	**0.048**
Early change	10	7 (70.0)		8 (80.0)		6 (60.0)		6(60.0)		4 (40.0)	
Moderate	31	17 (54.8)	0.148	20 (64.5)	0.845	13 (41.9)	0.935	12(38.7)	0.088	3 (9.7)	0.468
Late change	5	1 (20.0)		3 (60.0)		2 (40.0)		0(0)		0 (0)	
Lost support	52	24(46.2)	-	28(53.8)	-	23(44.2)	-	16(30.8)	-	10(19.2)	-
Female											
Complete	31	16 (51.6)	0.051	19 (61.3)	0.167	13 (41.9)	0.212	10(32.3)	0.179	4 (12.9)	0.445
Early change	4	0 (0)		1 (25.0)		3 (75.0)		0(0)		0 (0)	
Moderate	41	21 (51.2)	0.099	14 (34.1)	0.728	23 (56.1)	0.423	6(14.6)	0.253	5 (12.2)	0.847
Late change	10	8 (80.0)		4 (40.0)		7 (70.0)		3(30)	0.353	1 (10.0)	
Lost support	49	29(59.2)	-	21(42.9)	-	25(51.0)	-	15(30.6)	-	7(14.3)	-

$IPE: Both of protein and total energy intake

#IPEB: All of three items (protein, total energy and BMI)

* chi-square test.

Table 4. Multivariable logistic regression analysis to examine the odds ratio of PE and PEM in male Early change group

Independent variable		Crude odds ratio	95%CI	Adjusted odds ratio$	95%CI	p-value
Protein + Total energy (IPE)						
	Early change *ref: others*	3.9	1.1 - 14.8	4.0	1.0-15.6	0.045
Protein + Total energy + BMI (IPEB)						
	Early change *ref: others*	4.0	1.0 - 15.7	4.3	1.0-17.6	0.045

$: adjusted for education, difference of TMIG index and medical history (diabetes mellitus, hypertension and renal disease)

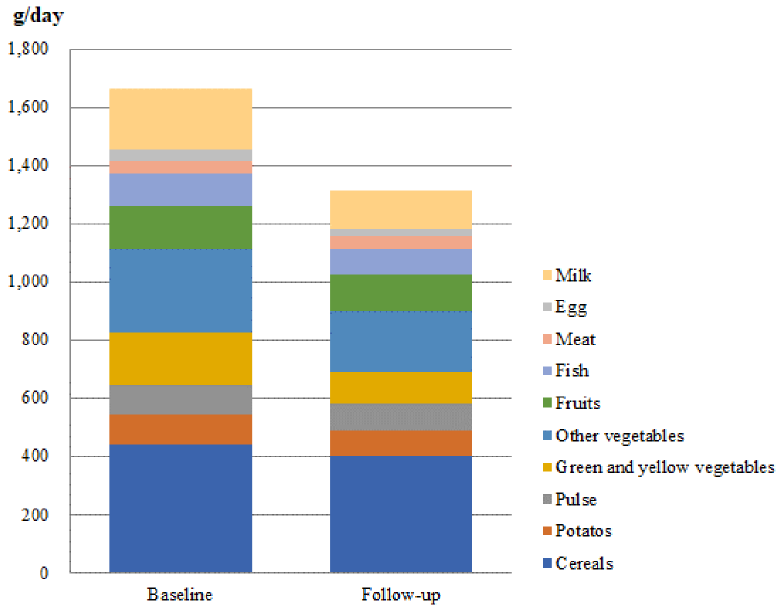

Fig. 2 Amounts of intakes of green and yellow vegetables, other vegetables and milk were significantly decreased over 5 years in male Early change group ($p<0.05$). That of egg was tended to decrease ($p = 0.055$). These p-values were from paired-t test.

40% and participants with no changes in occlusion such as Complete, Moderate and Lost support group were 9.7-14.3 %. The proportions of subjects in male Early change group with insufficient in protein and IPE and IPEB were significantly higher than those of Complete group ($p = 0.035$ for protein intake, 0.007 for IPE and 0.048 for IPEB). There were no significant associations in all items between Moderate and Late change groups for male. For female, there were no associations between the changes of POSS and all malnutrition evaluations.

Table 4 presented the results of multivariable logistic regression analysis to examine the odds ratio of IPE and IPEB in male Early change group after adjustment for education, difference of TMIG index and medical history (diabetes mellitus, hypertension and renal disease). Male Early change group had significantly higher risk of IPE and IPEB (odds ratio: 4.0 for IPE and 4.3 for IPEB, $p = 0.045$ for both of IPE and IPEB). In male Early change group, amounts of intakes of vegetables and milk were significantly decreased over 5 years ($p<0.05$) (Fig 2).

Discussion

The current study assessed the relationship between posterior occlusal support status and protein intake, total energy intake and BMI based on the status of PEM in independent community-dwelling elderly people. In our result, it was founded that changes of nutrition intake and BMI over 5 years were relatively small because our subjects were generally active and living independently.

Indeed, change of serum albumin level was not able to determine malnutrition (PEM) because that in baseline and follow-up has hardly changed. Thus, we defined two malnutrition criteria: IPE: declined in nutrition intake, and IPEB: declined in BMI with poor nutrition intake. In our study, there were also significant differences between male and female in protein intake, total energy intake, BMI and serum albumin level at baseline, which followed previous study reports that nutrition intakes were different by gender [21-24]. Consequently, we assessed relationships between changes of POSS and malnutrition by gender.

According to Bianchetti A, et al. poor nutrition intake was correlated with socioeconomic conditions, functional level and affective status [25]. Thus, we selected education levels, TMIG index and medical history as covariates for multiple logistic regression models to assess associations between changes of POSS and each malnutrition criterion. The odds ratio of IPE and IPEB which was adjusted for these covariates were 4.0 and 4.3 respectively in male Early change group compared to others. Additionally, in terms of intakes of food groups, we noticed that amount of intakes of green and yellow vegetables, other vegetables and milk were significantly decreased ($p<0.05$) and egg was tended to decrease ($p=0.055$) in male Early change group (fig. 2). Yamashita M reported that for elderly male living alone, the frequency of intake of cereals, vegetables and green-yellow vegetables was significantly lower and fats and oils was significantly higher than couple household male [23]. Although the current study did not ask whether their family members were living together, result of reduction of vegetables and green-yellow vegetables in elderly male showed a similar tendency.

It was also noted that significant differences in IPE and IPEB were only found in Early lost stage male. The early stage of losing POSS might be considered as a risk factor of malnutrition for male. Takemi Y, et al. reported that the diversity of food intake for male was decreased more than for female, and a risk of malnutrition was concerned for male [24]. Because many elderly male living alone felt loneliness without being able to communicate with the surroundings [23] and it might affect to unbalanced food intake. From these findings, it would be suggested that elderly male may have higher risk to become malnutrition along with environmental changes whether they could be difficult to adapt themselves. Changes of POSS might be related to their environmental changes, and may cause to increase risk for malnutrition in Early change group. However, our data in Late lost stage did not show increment of malnutrition, we failed to confirm its causality.

Ministry of Health, Labor and Welfare in Japan indicated that motivation, knowledge and skills of the behavior modification are necessary for elderly to prevent malnutrition and keep their health [26]. Therefore, to prevent tooth loss, nutritional instruction might be essential for elderly who may have lost posterior OSZ in early stage.

There is a limitation in this study. Although additional determinants related to food intake other than dentition status, such as nutritional knowledge, cooking skills, presence or absence of person who has lived together and abnormality of oral function were important [27], however, we failed to present such data assessment in our current result. We are conducting further survey including above determinants on the condition after 10 years in subjects with a high tendency of malnutrition.

Conclusions

Our findings suggested that elderly male who were in early stage of losing posterior occlusal support status declined protein intake and increased to be malnutrition.

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